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THE TRANSMISSION AND CONTACT SYSTEMS USED ON THE ELECTRIFIED DIVISIONS OF THE C., M. & ST. P. RY. CO.

BY MARSTON CURTIS*

Mr. Curtis presents a very timely article which should be of interest to all of our readers. According to the engineers in charge the electrification of that stretch of the road which covers three mountain ranges and has many long distance grades of from 1½ to 2 per cent will double the capacity. The railway company expects the same result as if the line over the mountain divisions would have been double-tracked.—The Editors.

The C., M. & St. P. Ry. Co. will be operating their first electrified division on the main line to the Pacific Coast very soon after this article goes to press, and it seems that now is the proper time to give the undergraduates and alumni an idea of the transmission and contact systems used on this project.

The first division will consist of 112.2 miles of main line single track from Three Forks to Deer Lodge, Mont., and in this territory will cross the Continental Divide at an elevation of 6,322 feet above sea level, by winding in and out of the canyons of the Rocky Mountains. The second division to be electrified extends from Three Forks east to Harlowton, Mont., a distance of 114.2 miles, crossing the Big Belt Mountains, and will be in operation by the early part of 1916. Construction work has already been started on the third division, which really consists of two engine divisions, extending from Deer Lodge, Mont., west to Avery, Idaho, a distance of 211.2 miles, crossing the main range of the Bitter Root Mountains at an elevation of 4,133 feet above sea level.

In this electrified territory are located fourteen substations, seven of which are practically complete, and the balance of

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which are in the process of construction. The stations vary in capacity from 3,000 K. W. to 4,000 K. W., depending upon the load conditions which will be imposed upon them resulting from the proximity to other stations, track grade, and curvature. Seven substations will have power taps to the various transmission lines of the Montana Power Co., who are supplying power to the railroad at a potential of 100,000 volts.

The Railway Company's transmission line, which connects all but two of the substations together, consists of a three-phase, 60-cycle, 100,000 volt alternating current line supported on wood poles. Seven standard types of construction have been used to take care of different alignment and anchorage conditions, and may be classified in two groups, namely, normal construction, including plane, tangent and curve structures, and special construction, to take care of heavy angles, anchorage and long span conditions.

Figures 1, 2 and 3 show the tangent, right and left-hand curve type of construction, respectively, and are used on spans up to 450 feet, or on those which give a weight on one pole equivalent to 450 feet each of three transmission wires, which are 2/0 hemp core, six strand medium hard drawn copper wire, and one ⅜-inch Siemens-Martin galvanized steel strand ground wire. The standard length of spans on tangent work is 300 feet. The tangent pole is also used on curves up to one degree or angles of three degrees with the additions of a ⅜-inch S. M. guy. The curve types of construction are used on curves over one degree and on angles up to ten degrees, the span length being such that this angle is not exceeded on curves.

On spans where there are more than 450 feet of wire on a tangent pole, the construction shown in Fig. 4 is used, which is similar to that in Fig. 1, except for the double arms and two side guys. Angles of from ten to thirty degrees are built on a two-pole structure, similar to that shown in Fig. 6, except for the length of the cross arms. Where the angles are between thirty and ninety degrees the type shown in Fig. 5 is used. These, as well as the tangent construction in Fig. 6, are anchorage structures and serve to dead end the transmission line. One of these two pole structures is built in the line at least every mile, so that any failure in the pole line will amount to but a


Fig. 1
Fig. 2
Fig. 3
Fig. 4

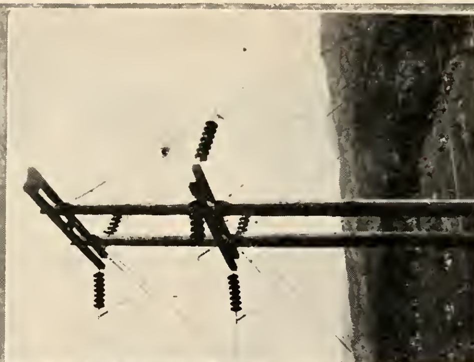

Fig. 6

Fig. 7

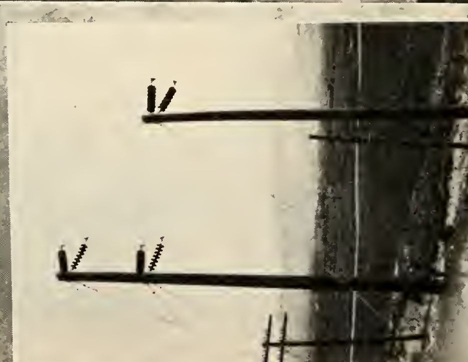

Fig. 5

comparatively small matter. Anchorages are also inserted in the line wherever there is a change in the tension of the wire, due to sections of extra long spans, such as over canyons, adjacent to standard spans.

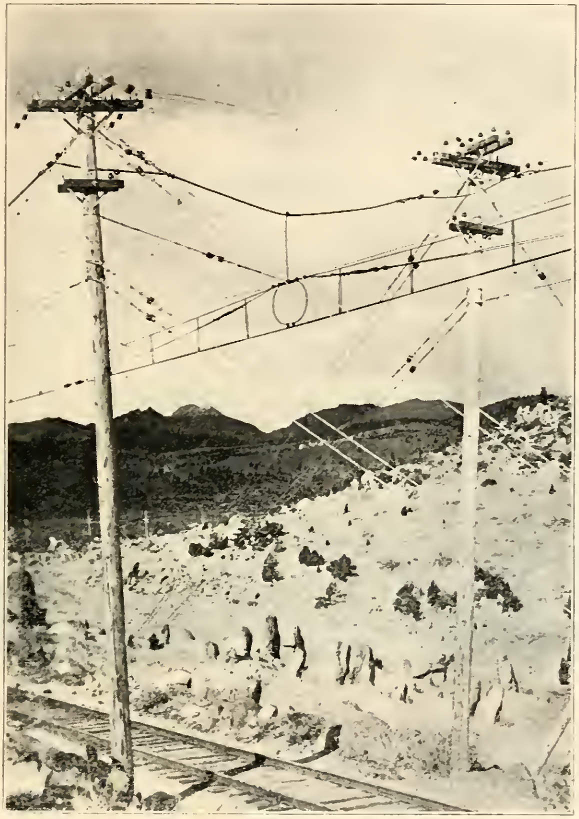

Fig. 8.

The feeder systems, which also serve as a tie on the 3,000 volt direct current side of all substations, is carried on the four-pin cross arm on the trolley pole. Fig. 7 also shows a feed tap to the two 4/0 copper contact wires, such taps occurring every thousand feet. The size of the feeder varies from one 500,000 circular mil bare copper cable to two 700,000 c. m.

cables, depending upon load conditions. Fig. 8 shows a feeder, signal and power-limiting wire crossing (the latter wires were not strung when the photograph was taken), and also a feed tap and a trolley and messenger anchorage.

The trolley and feeder systems are provided with "air breaks" in the former and cut-out knife switches in the latter, at the end of all yards and passing tracks, substations, and at each end of all long tunnels. This provides a means of killing a section of feeder and trolley in case of an accident, and at

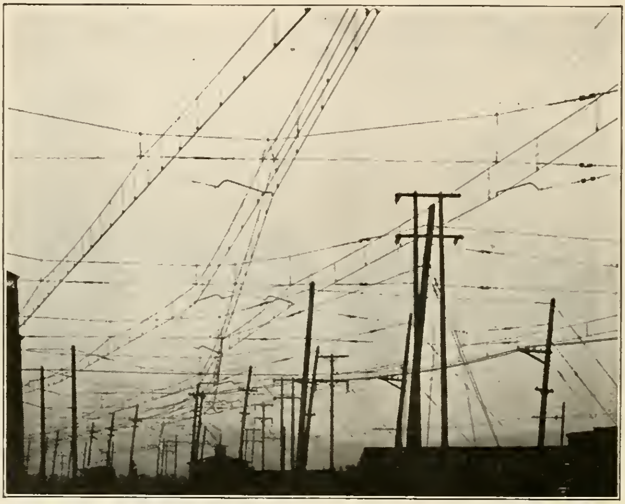

Fig. 9.

the same time allow the remainder of the system to be in operation.

The contact system consists of two 4/0 grooved copper wires on the main line, and one wire on passing track and guard tracks, Figs. 7, 8 and 9, suspended from one messenger of ½ inch high strength steel strand by catenary hangers placed every fifteen feet on the contact wire. The hangers are so placed on the main line that those on one wire stagger those on the other, which results in having a hanger every seven and a half feet on the messenger. The object of the double contact wire is to eliminate sparking at the pantograph due to "hard spots" in the

line, and also to provide sufficient current carrying capacity for the locomotives.

The return current system consists of the track rail return through bonds, and the supplementary negative consisting of a 4/0 stranded copper conductor shown near the top of the pole in Fig. 7. All main line rails are bonded, while passing and yard tracks have only one rail bonded, all bonds being of 250,000 c. m. pin type. Two bonds per joint are used on the main line over the heavy mountain grades, while one is used elsewhere. The rail is tapped to the supplementary negative every 4,000 feet, and the latter is used mainly as a protection to section men and as a lightning protection to the wires on the trolley poles.

FACTORS OF DESIGN FOR TWO-CYCLE OIL ENGINES

BY D. O. BARRETT, M. E.*

Although the internal combustion engine has not heretofore been used in large sizes to any great extent in this country, the field for their use is rapidly widening. Their low fuel cost combined with an entire absence of "standby losses" and many other operating advantages which result in marked economy has lead to the use of the oil engine in a great variety of industries. Mr. Barrett presents the many formulas that he has developed pertaining to the low-compression type of oil engines which information, heretofore, due partially to the reluctance of the manufacturers, has not been published.—The Editors.

In this article will be taken up some factors of design pertaining to the two-cycle low-compression, or as it is commonly called, the semi-Diesel type of crude oil engine. Outside of the Diesel engine this is the only engine which has proved a success from the standpoint of continued usage when operating on such heavy fuels as crude or fuel oils. While many other types of engines using these heavy fuels have been constructed, yet with one or two exceptions these have practically been failures, and have been withdrawn from the market after a few years use. To those familiar with this type of engine there are good reasons why these particular engines have failed to stand up, and the cross-head type of engine at the present time has practically no competitors, due to the simple process of elimination. The first engines of this type were designed along steam engine lines as regards constructional features, and there were of course, many failures due to these parts not being sufficiently heavy to withstand the increased stresses. However, at the present time there are several manufacturers of this type of engine, and we might say that they have no rivals except among themselves in certain fields. They are built in the single cylinder up to 100 horse power, and in the twin type up to 200 horse power. In these smaller sizes the lower fuel consumption of the Diesel engine is not of sufficient importance to justify the high first cost necessitated by their mechanical construction. These low-compression engines have proved especially desirable for irrigation work, and are now entering very successfully the electric lighting field, as they give extremely close regulation, and are very suitable for long continued runs without shut-down.

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*Class of 1908.

The cheaper engines in this class range in price from $20 to $25 per horse power, while the better constructed engines vary from $30 to $40 per horse power. Practically all of these engines will give a guaranteed fuel consumption of less than one-tenth gallons per delivered horse power hour, and much better results than this may be actually obtained. The writer has made many tests of the various sizes of engines in which the brake horse power was delivered with a fuel consumption of 0.60 lb. of fuel oil per hour, oil of 30 deg. B being used. This fuel costs in the neighborhood of three cents per gallon delivered, so the actual fuel cost per brake horse power hour would be only 0.24 cents.

There has been a great deal of matter written on the design of the Diesel engine, as this type has become fairly well standardized, but practically nothing has appeared pertaining to the low-compression type. This is due partially to the reluctance of American manufacturers to impart any information relative to their product. The two-cycle type of engine has been merely an experimental proposition for many years, and it was first necessary for the engine to pass through this experimental stage before becoming standardized.

The formulas given in this article have been developed by the author from a large number of existing engines of this type, including various sizes, from 10 to 100 horse power, and may be said to fairly represent good average practice. They give, perhaps, slightly larger dimensions than are found on the average engine of this type at the present time, for it must be remembered that these engines have not yet reached the state of perfection which is to be expected from them when comparing them with oil-burning engines of the Diesel class and for this reason the formulas presented will give sizes which will apply to the most highly developed engines along these lines, and will give satisfactory results when considering the future developments which are bound to follow with this engine.

On the accompanying plates are shown sectional views of the best-known engines of the crosshead type. Some of the particular features of design of the various makes will first be pointed out in order that they may be referred to later. The

following classification might be made to better distinguish them:

Two-port type.	Two-port type.	Three-port type.
Mechanically-operated inlet valve.	Suction-operated inlet valve.	Piston-controlled port.
Bessemer.	Primm.	Loomis.
Nordberg.	Ingersoll-Rand.	Giant.

On Plate 1 is shown the Bessemer engine. In this engine the crank-case or bed is entirely enclosed and the working parts lubricated by splash. The cored space in the bottom of the bed is used for the passage of the circulating water in order to keep down the temperature of the lubricating oil. A cylinder head of special design is used, the oil being sprayed in at the bottom. In starting, the small ignition tube shown projecting at an angle from the head is heated, a portion of the oil spray striking this and causing combustion. The air for combustion is taken in through a mechanically operated valve of the Corliss type, shown in the bottom of the bed just beneath the end of the cylinder. This valve is operated from the crankshaft by means of an eccentric and rocker arm. The large space around the cylinder in the bed is used to keep the maximum pressure of the scavenging air within certain limits, in this case being about 5 lbs., as determined from an indicator card loaned by the manufacturers. A flange is cast around the cylinder some distance from the end, by which it is bolted to the bed. In practically all of these engines the water space extends around only that portion of the cylinder proper which is actually exposed to the heat of combustion.

Plate 2* shows the Primm engine. This engine is supplied with a suction-operated valve in the base. The base extends back under the cylinder, being bored to the same diameter as that to which the outside of the cylinder is turned, thus making an air-tight joint between the two. This space is connected to the air-jacket of the cylinder and is of such capacity as to give a pressure in the air pump of from 6 to 8 lbs. The cylinder head is air-cooled and the ignition device consists of a removable tube which may be heated in a torch or other flame, gas-tightness being obtained by means of a ground joint and it is held in place by a quick-acting clamp. The fuel is sprayed onto this

*This plate was not received in time for publication.

tube from the top. Ports are placed around the bed end of the cylinder connecting with the air packet.

The Loomis engine (Plate 3) is provided with a piston-controlled inlet port and the cylinder head and ignition device are very similar to that used on the Bessemer engine. The cylinder is supported under the exhaust port on an extension of the bed in order to provide a rigid construction. The air entering the cylinder may be throttled by a hand-controlled valve shown in the inlet pipe.

The Nordberg engine shown in Plate 4 does not properly belong to the semi-Diesel class as a compression of about 450 lbs. is used, being similar to the Diesel in this respect. However, compressed air is not used for the injection of the fuel, thus greatly simplifying the construction of the engine. The injection is directly by pump as in the other engines and the heat generated by the compression is sufficient to automatically ignite the oil. The constructional features of the engine, however, are very similar to the other engines shown and for this reason it is listed with them. The cylinder is provided with an enlargement at the top in order to secure the proper terminal pressure for the scavenging air. The cylinder is bolted to the bed at the end and is provided with a support in the form of an exhaust box resting directly on the foundation.

Plate 5 shows the Giant engine, this being of the three-port type. It is somewhat different from the Loomis engine in that the air-pump end of the cylinder is somewhat enlarged in order to lower the air pump pressure. This might be termed a short-strike engine as the stroke is in no case greater than the bore of the cylinder. The extension of the cylinder at the bottom rests directly on the foundation. The fuel is injected at the center of the cylinder head and strikes a circular plate placed on the end of the piston, which acts as an ignition device.

Plate 6 shows the Ingersoll-Rand engine. Splash lubrication is here employed and the cylinder and bed are each provided with a stuffing-box so that these may be adjusted while the engine is in operation. A suction operated valve is used in which thin steel rings are the movable members. The cylinder is not enlarged so that the air-pump pressure will correspond very nearly to that in the Loomis engine. One feature differing from

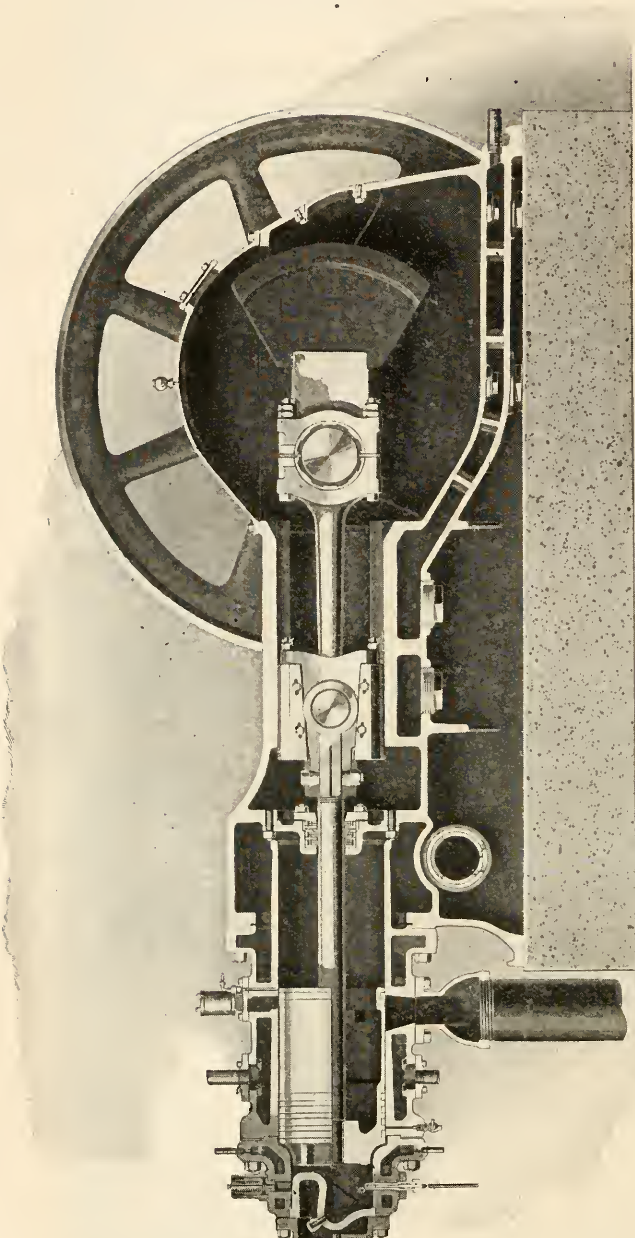

Plate 1. "Bessemer." Courtesy Bessemer Gas Engine Co., Grove City, Pa.

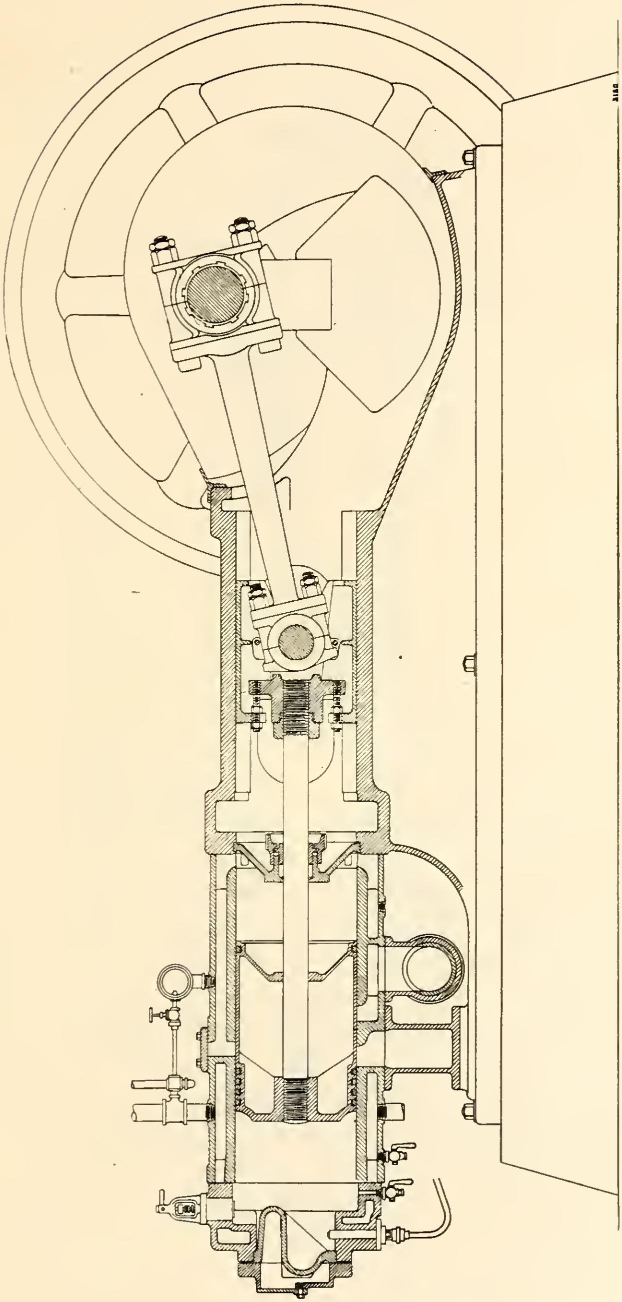

Plate 3. "Loomis." Courtesy Johnston & Jennings Co., Cleveland, Ohio.

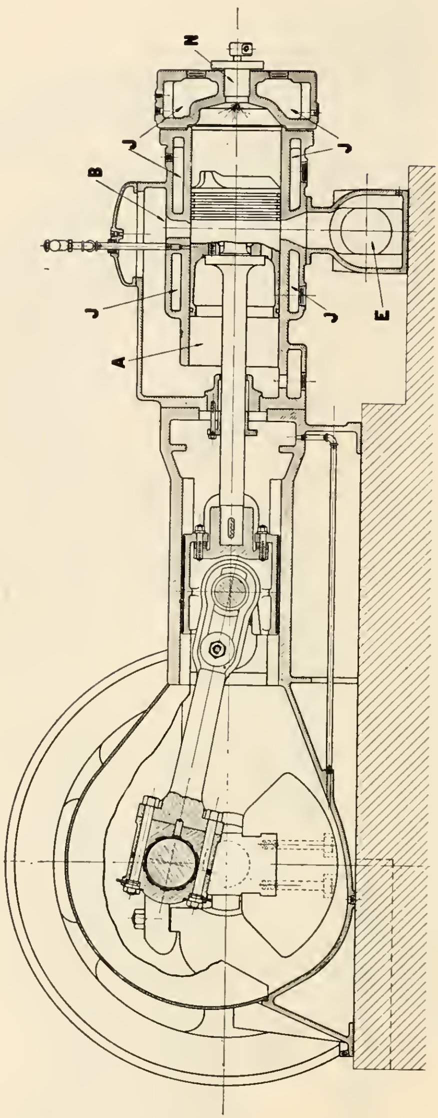

Plate 4. "Nordberg." Courtesy Nordberg Manufacturing Co., Milwaukee, Wis.

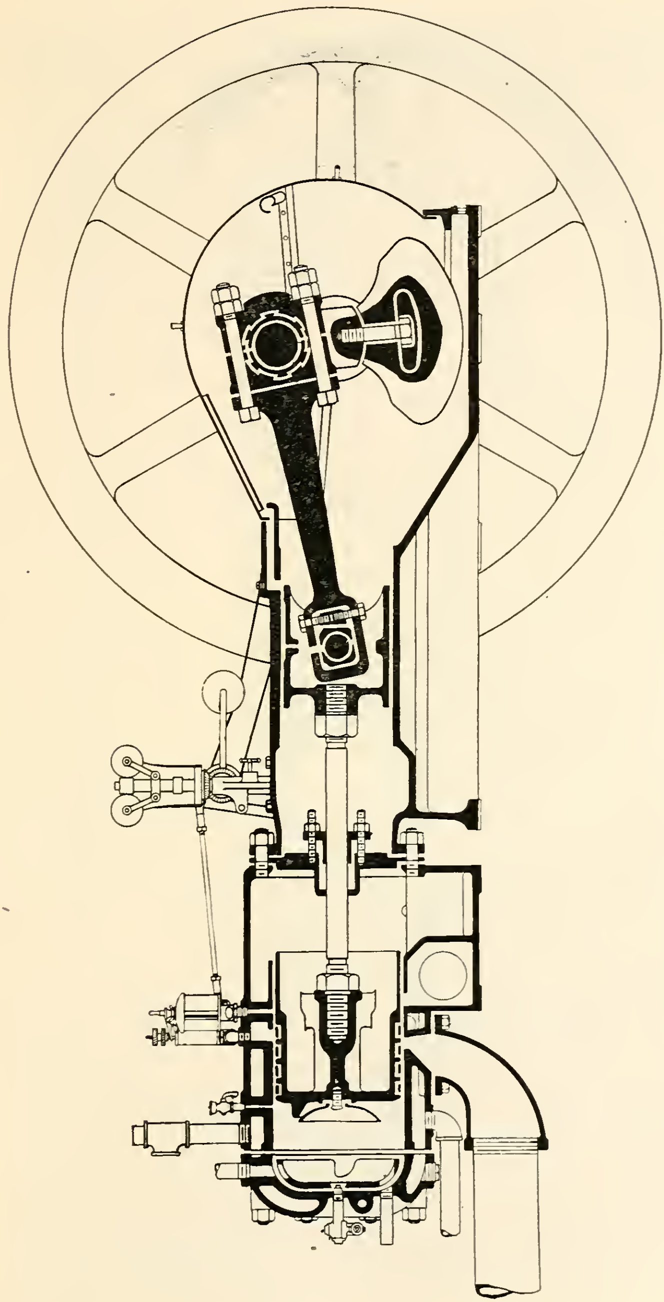

Plate 5. "Giant." Courtesy Chicago Pneumatic Tool Co., Chicago, Ill.

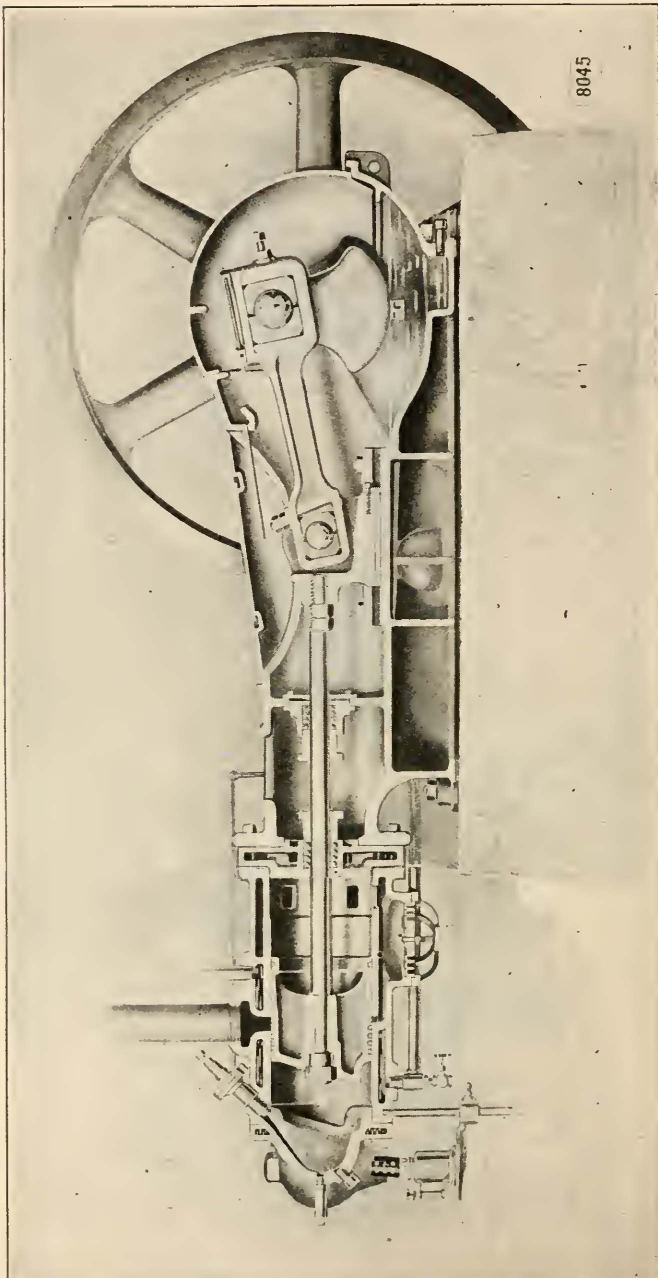

Plate 6. "Ingersoll-Rand." Courtesy Ingersoll-Rand Co., New York, N. Y.

any of the other engines shown is that the transfer port is at the bottom of the cylinder and the exhaust at the top. The cylinder head is of special design, the oil being sprayed into the head at an angle.

In Fig. 1 are shown some indicator cards from the air pump end of the cylinders. These were very kindly loaned to the writer by the manufacturers. Card No. 1 is taken from a 12"x16" Bessemer engine running at 250 r. p. m, and shows very plainly the operation of the mechanically-operated valve. The maximum pressure is 5 lbs. and the suction 1 lb.

Fig. 2 shows a card from the Nordberg engine; this engine uses a mechanically-operated valve of a somewhat different type than the Bessemer being very similar to the piston valve used on locomotives. The maximum pressure and suction as measured from the card are 8.5 lb. and 1.2 lb. respectively. The card from the Primm engine was taken from a 14" x 18" running at 250 r. p. m. and shows a maximum pressure of 8.75 lb. and a suction of 0.5 lb. This suction is somewhat less than that shown on either of the preceding cards and shows that a properly designed suction-operated valve may give just as good or better results than the mechanically-operated valve. One advantage of the mechanically-operated valve, which is shown quite plainly in card No. 2, is that by properly timing same, advantage may be taken of the inertia of the inrushing air to "pile up" same at the end of the suction stroke, thus beginning the compression stroke at a greater pressure than atmospheric with a corresponding increase in the volumetric efficiency of the pump.

Card No. 4, while not taken from a Loomis engine, is distinctive of this type and shows the effect of the piston-controlled port by the extreme suction which is created. The maximum pressure varies from 12 to 15 lb.

The aim of the designer is, of course, to handle as large an amount of scavenging air as possible and while it is impossible to ever attain 100 per cent efficiency due to the opening of the transfer port before the end of the stroke, yet by a careful design of ports and deflectors it is possible to produce a suction in the pump even while the air is being transferred into the cylinder at the other end. This is shown quite plainly by cards

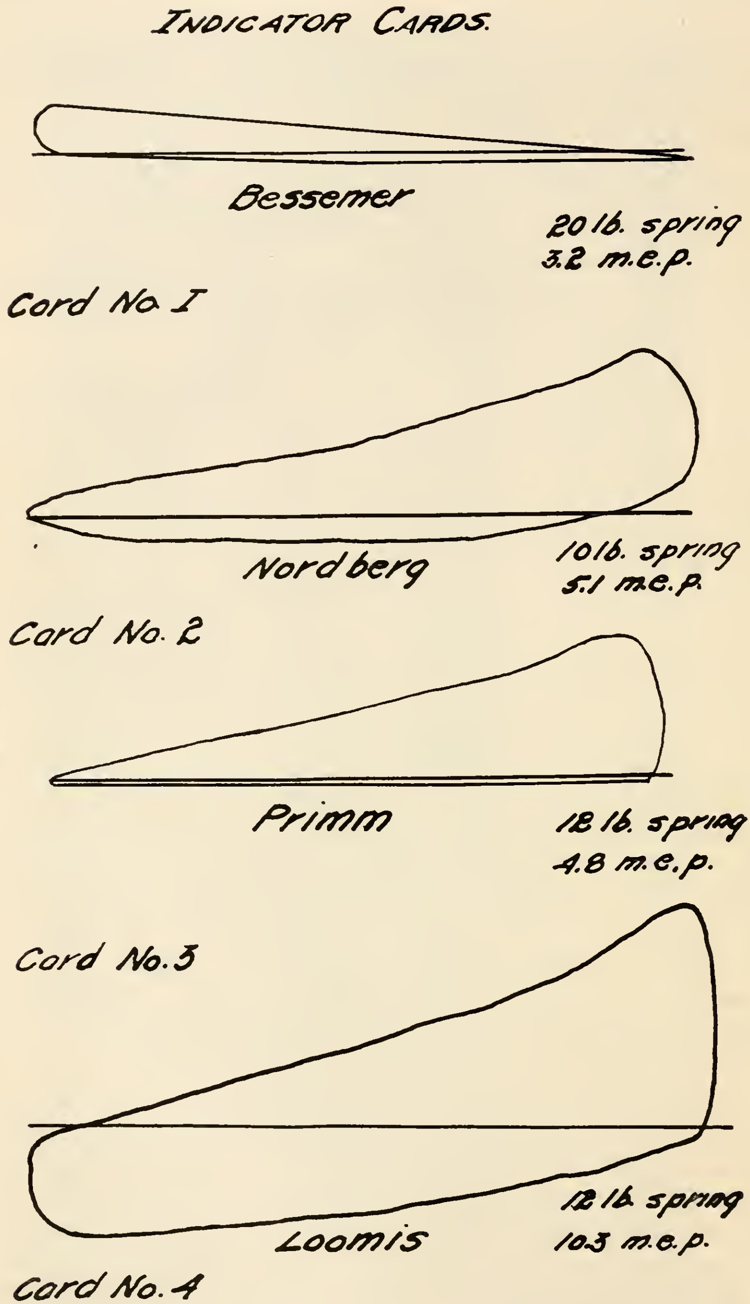

Fig. 1. Indicator Cards Taken from the Air Pump End of the Cylinders.

Nos. 3 and 4. The volumetric efficiency as determined from the various cards is as follows: No. 1—86.5%; No. 2—90%; No. 3—97%; No. 4—88%. It is thus seen that in a properly designed engine of the three-port type it is possible to handle as large a quantity of air as in those of the two-port type. However, it is handled at a much greater operating cost due to the extreme suction. It must be remembered, however, that there are no mechanical troubles with valves or operating mechanism as these are entirely eliminated. Since the m. e. p. is considerably higher the fuel consumption of the three-port type will be slightly greater than the two-port, and for this reason this construction is not as desirable as the latter.

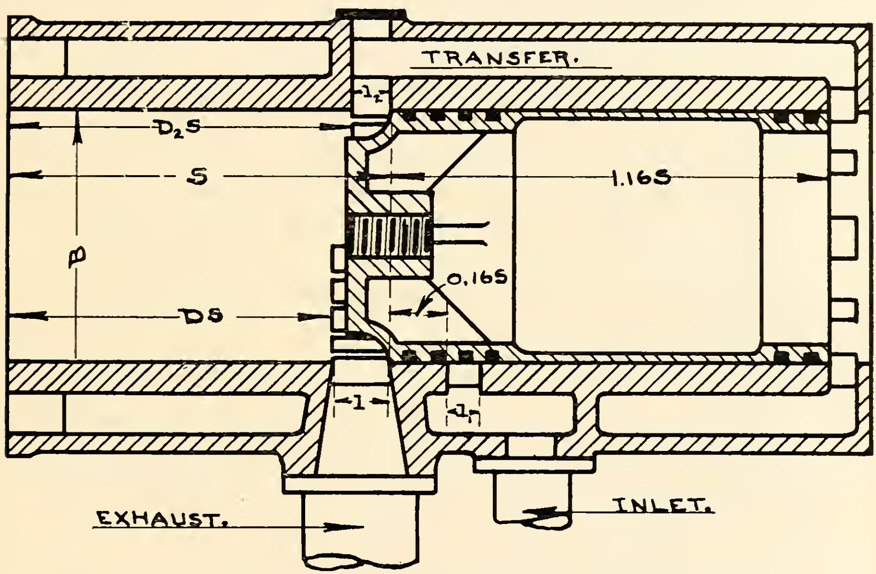

Fig. 2. Section Thru a Cylinder of the Three-Port Engine.

CYLINDERS—

Taking up now the question of cylinder and port design, reference will be made to Fig. 2 wherein a section thru a cylinder of the three-port type is shown. The size of the transfer and exhaust ports remain the same whether the engine be of the three or two-port type, the controlling factor being the maximum pressure which is used for scavenging. We may take

two classifications in this respect, one in which this pressure is carried from 12 to 15 lb. and the other where the pressure varies from 5 to 8 lb. The following symbols will be used:

B = Bore of cylinder, in inches.
S = Stroke of piston, in inches.
R = Revolutions per minute.
L = Length of connecting rod, in inches.
P = Piston speed, in feet per minute.
V = Velocity thru exhaust port, in feet per minute.
V_1 = Velocity thru inlet port, in feet per minute.
V_2 = Velocity thru transfer port, in feet per minute.
l = Length of exhaust port, in inches.
l_1 = Length of inlet port, in inches.
l_2 = Length of transfer port, in inches.
w = Width of exhaust port, in inches.
w_1 = Width of inlet port, in inches.
w_2 = Width of transfer port, in inches.
D = Percentage at which exhaust port opens.
D_1 = Percentage of stroke at which inlet port opens.
D_2 = Percentage of stroke at which transfer port opens.

From the above we have,

Area Cyl. $= 0.7854\ B^2$; Total cyl. vol. $= 0.7854\ B^2\ S$.

$$R = \frac{12 \times P}{2 \times S} = \frac{6\,P}{S}\ ;\ l = l - D\ ;\ l_1 = D_1\,S\ ;\ l_2 = (l - D_2)\,S.$$

In laying out port openings they should always be expressed in degrees of crank travel as the time element may thus be easily obtained. The following included port openings are recommended:

Exhaust, 102°; inlet, 86°; transfer, 84°.

The recommended gas velocities thru the various port openings are as follows, full port opening being assumed thruout the entire time during which the port is uncovered:

Exhaust, $V = 4{,}000$; Inlet, $V_1 = 10{,}000$; Transfer, $V_2 = 16{,}000$.

The above values of V_1 and V_2 are for the aforementioned cases in which the scavenging pressure is carried at from 12 to 15 lb. Where a pressure of from 5 to 8 lb. is carried the following velocities should prevail:

Inlet, $V_1 = 8{,}000$; Transfer, $V_2 = 11{,}000$.

In machining a cylinder of the type shown in Fig. 2 the distance from the head end of the cylinder to the opposite ends of the exhaust and transfer ports is made equal to the stroke, the deflector or any projections on the end of the piston thus entering the cylinder head when the piston it at the end of the stroke. Where the engine is of the three-port type care must be exercised to see that the length of the piston is exact as upon this depends the timing of the inlet. Various methods are used in fastening the piston rod in the piston as shown in the sectional cuts, the most common method, however, being to screw same in and then rivet over the end. By using the same construction for fastening the rod in the crosshead it is possible to adjust the position of the piston should the length of the bed or cylinder not exactly correspond to those called for on the drawings. It also furnishes a ready means of varying the compression, should this be desirable for any reason.

The thickness of metal between the exhaust and inlet ports may be made 0.16 the stroke so the length of the piston will then be 1.16 S. This brings the open end of the piston even with the edge of the port when open.

The time during which any of the ports are open for any given angular opening are dependent upon the ratio of connecting rod to crank. To more readily use the formulas the percentages of stroke at which the ports will open and close for ratios of rod to stroke varying from 1.8 to 3.0 are given for the previously recommended port openings:

$$x = L \div S.$$

.x	.D	.D_1	.D_2
1.8	85.6	16.7	90.3
1.9	85.5	16.5	90.2
2.0	85.3	16.4	90.0
2.1	85.1	16.2	89.8
2.2	84.9	16.1	89.7
2.3	84.7	16.0	89.6
2.4	84.6	15.9	89.5
2.5	84.5	15.8	89.4
2.6	84.4	15.7	89.4
2.7	84.3	15.6	89.3
2.8	84.2	15.5	89.2
2.9	84.1	15.4	89.1
3.0	84.0	15.3	89.0
	Exh.	Inl.	Tran.
	102°	86°	84°

The width of port now remains to be determined, the length having been given as a percentage of the stroke. The lengths are measured parallel to the axis of the cylinder and the widths around the cylinder. It must be understood that the widths spoken of mean the combined width regardless of the number or sizes of bridges which divide up the total opening the smaller ports. The widths of these openings or ports depend upon the bore of the cylinder and should be made as large as possible in order to prevent the forming of carbon deposits which may in time entirely close them. If made too wide, however, the ends of the piston rings will catch on the edges, either breaking off entirely, or making a disagreeable clicking noise when running, and the ends of the rings will in time be worn down and rendered useless. The bridges dividing the ports vary in width from 3/8″ to 2″ depending upon the length of the port. These bridges are subjected to a tensile stress and, in the case of the exhaust port, the extreme heat makes the service very severe as there is no practical method of cooling. The cooling water should be brought as closely as possible around the exhaust opening. The exhaust pipe and header where the pipe joins the cylinder should give a larger opening than those of the ports in order that no back pressure be developed with a consequent increase in the heat at this point.

In any calculations concerning cylinder volumes it must be remembered that only that portion of the stroke up to the opening of the ports is effective. This is one of the reasons why the two-cycle engine can never give the same m. e. p. as the four-cycle. This lowering of the volumetric efficiency is in direct proportion to the width of the ports.

EXHAUST PORTS—

The volume of gas to be exhausted per revolution is 0.7854 B^2 D S cubic inches. This gas has to pass thru an opening of area lw and the length of this column of gas will, therefore, be $\frac{0.7854\ B\ D\ S}{l\ w\ 12}$ feet. The fraction of a revolution during which

exhaust takes place (102°) is $\frac{102}{360}$. Therefore the time in which one exhaust takes place is

$$\frac{102}{360\,R} \text{ or } \frac{102\,S}{6 \times 360\,P} = \frac{S}{21.17\,P} \qquad (1)$$

The velocity in feet per minute thru the port will then be expressed by

$$V = \frac{0.7854\,B^2\,D\,S\,21.17\,P}{l\,w\,12\,S} = \frac{1.386\,B^2\,D\,P}{l\,w} \qquad (2)$$

solving for w we have $w = \frac{1.386\,B^2\,D\,P}{l\,V}$

but $l = (1 - D)\ S$

so that $w = \frac{1.386\,B^2\,D\,P}{(1 - D)\,S\,V}$ (3)

If we assume a value of $x = 2.3$, which is about the average, we shall find the corresponding value of D to be 0.847. An average piston speed is 700 ft. per min. and $V = 4{,}000$. Substituting we then have:

$$w = \frac{1.386\ B^2\ 0.847\ 700}{0.153\ S\ 4{,}000} = \frac{1.343\ B^2}{S} \text{ width of exhaust port} \qquad (4)$$

In similar manner for the inlet we have

$w = \frac{1.644\ (1 - D)\ B^2\,P}{D_1\ S\ V}$ or substituting as above

$$w = \frac{1.644\ O\ 84\ B^2\ 700}{D_1\ 16\ S\ 10000} = \frac{0.604\ B^2}{S} \qquad (5)$$

or where an allowable velocity of 8,000 is used,

$$w = \frac{0.755\ B^2}{S} \qquad (6)$$

For the transfer port,

$$w_2 = \frac{1.683\ (1 - D)\ B^2\ P}{(1 - D_2)\ S\ V} \quad \text{substituting as above}$$

$$w_2 = \frac{1.683\ 0.84\ B^2\ 700}{0.104\ S\ 16{,}000} = \frac{0.595\ B^2}{S} \qquad (7)$$

or where an allowable velocity of 11,000 is used,

$$w_2 = \frac{0.865\ B^2}{S} \qquad (8)$$

The ports opening into the air jacket from the cylinder proper should be much larger than the regular transfer ports in order that there be no wire-drawing at this point. For the thickness of cylinder walls, diameter of studs, etc., the regular gas engine formulas will apply.

COMPRESSION—

After quite an extended investigation, the writer has found that the exponent n in the regular formula $P\ V^n = P_1\ V^n_1$ will closely approximate 1.33 or 4/3. In calculating compression the effective piston displacement, or cylinder volume must be taken as $0.7854\ B^2\ (1 - D)\ S$. while the pressure at the beginning of the compression stroke may be taken as 14.7. To facilitate matters, the curve shown in Fig. 3 has been drawn showing the relation between pressures and volumes, the range given covering that for ordinary oil engine work, for the average compression pressure is from 125 to 150 lb. altho some makers claim to use as high as 180 or 200 lb. but these are rare and the higher compressions do not seem to be justified by the fuel consumptions obtained. With the higher compressions the matter of starting is made somewhat more difficult.

PISTON RODS—

The diameter of the piston rod should be about 0.22 the bore.

$$D_{pr} = 0.22\ B \qquad (9)$$

CROSSHEADS—

With but one exception all the engines here shown use a crosshead of the cylindrical type the bed being bored at the

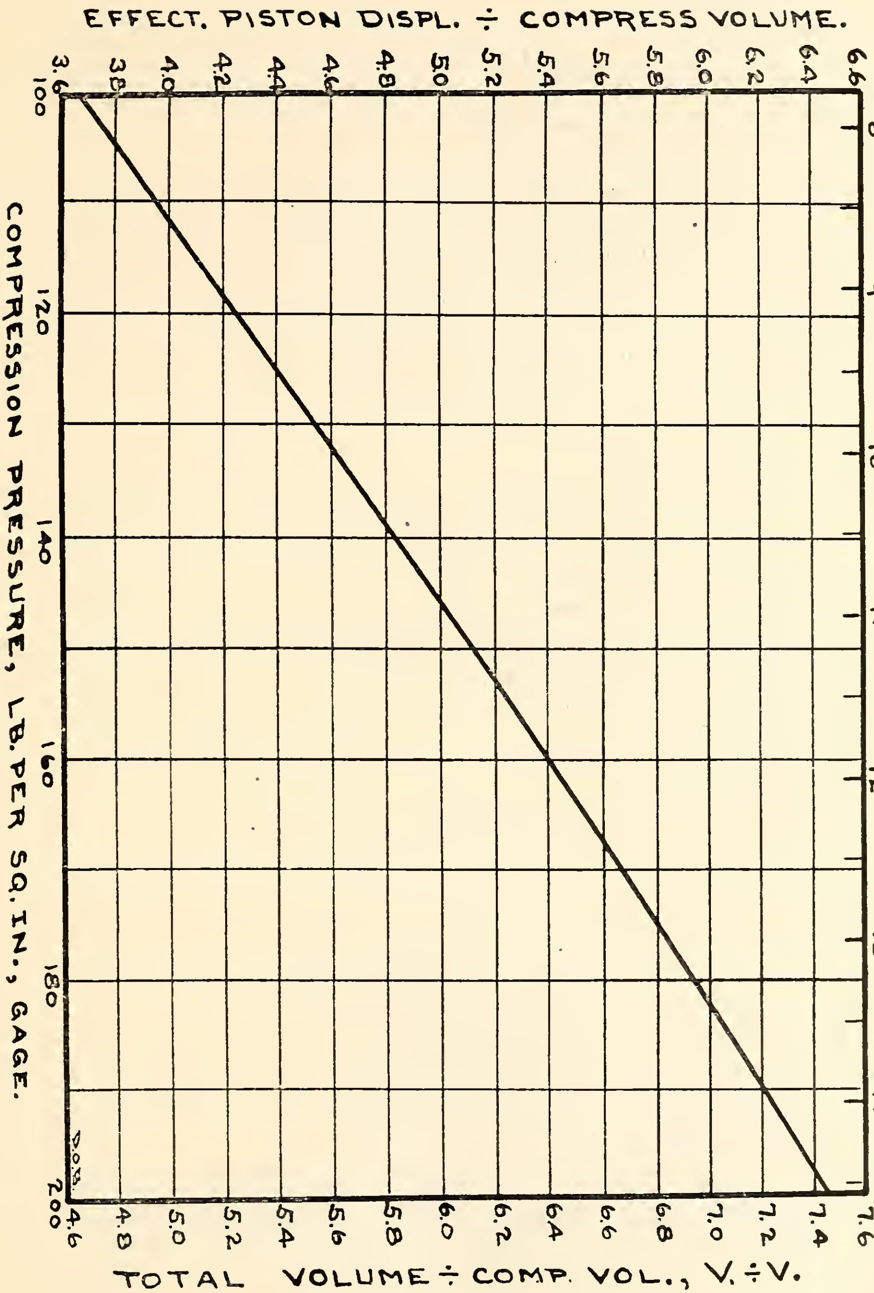
EFFECT. PISTON DISPL. ÷ COMPRESS VOLUME.
COMPRESSION PRESSURE, LB. PER SQ. IN., GAGE.
RATIO OF PRESSURES, P ÷ P₁.
TOTAL VOLUME ÷ COMP. VOL., V₁ ÷ V.

Fig. 3.

same time as being faced for the cylinder. The bore is usually made equal to the bore of the cylinder. The length varies from 0.8 to 1.0 times the bore. The projected area or the effective bearing should be about 0.65 B^2 so the width will be about 0.65 the bore. Some makers babbitt the crosshead, which is then peened and turned, while others use an iron to iron bearing. All are made adjustable, the various methods being shown quite plainly. In one engine the crosshead is made in one piece and the bottom bearing or shoe, as it is called is supported in the bed on screws in such a manner that it may readily be raised when desired. In practically all the engines the rod is screwed into the crosshead for reasons before stated.

CRANKSHAFTS—

The crankshaft is, perhaps, the most vital part of the whole engine and must be made sufficiently strong if satisfactory results are to be obtained. A weak crankshaft is evidenced immediately by the "wobble" of flywheels when running. Oil engine makers have suffered quite extensively from broken shafts as they attempted to follow gas engine practice. Due to preignitions and violent and sudden explosions the shafts must be designed to safely withstand stresses far above those found in normal operation.

Crankshaft formulas take the following form:

$$\frac{B^2\ S}{2\ D^3_c} = C$$

where D^c = Diameter of shaft.
C = Diameter constant.

The above formula reduces to the following form:

$$D_c = C_1 \sqrt[3]{B^2\ S} \qquad (10)$$

An average value for the constant C is 8 which reduces formula (10) to

$$D_c = 0.396 \sqrt[3]{B^2\ S} \text{ or say } D = 0.4 \sqrt[3]{B^2\ S} \qquad (11)$$

Now, the stroke is usually expressed in terms of the bore, or $S = a\ B$ or $a = S \div B$, then

$$D_c = 0.4 \sqrt[3]{a} \text{ or } D = x\ B \qquad (12)$$

The following table gives the values of x for different values of a from 0.9 to 1.7:

a	x
0.9	0.386
1.0	0.400
1.1	0.413
1.2	0.425
1.3	0.436
1.4	0.448
1.5	0.458
1.6	0.468
1.7	0.477

The length of the main bearings should be at least twice the diameter of the shaft.

The diameter of the crankpin is usually made about $1\frac{1}{8}$ times the diameter of the shaft, with the length about equal to the diameter.

The webs must be heavy enough so that there is a minimum of distortion which will be noticed immediately at the flywheels. Many cranks are too narrow in width while being amply heavy in the direction of rotation.

The equation for the webs may be written:

$$\frac{b + 2}{B^2 S} = C_2$$

where

b = Width of web.
t = Thickness of web.
C_2 = Web constant.

The ratio of thickness to width of web should be at least 2.2 or

$$t = 2.2\ b \tag{13}$$

The value of C_2 should be about 0.65 or substituting, we have:

$$t = 0.52\sqrt[3]{B^2 S} \tag{14}$$

The thickness of web may also be expressed in terms of the crank diameter since both are functions of the bore and stroke

$$t = 1.3\ D_c \tag{15}$$

WATER POWERS OF SOUTHEASTERN ALASKA

BY LEONARD LUNDGREN, C. E.*

Upon the suggestion of Mr. Lundgren we have considered this article from the students' standpoint and publish his report exactly as submitted to the United States Forest Service. The article should prove interesting in the study of how an engineer writes a technical report. Mr. Lundgren needs no introduction to Engineer readers and we are very glad to announce Mr. Lundgren will prepare a series of three articles on the Forest Service of the United States.—The Editors.

INTRODUCTION

Field Work and Assistance

A reconnaissance of water powers of Southeastern Alaska was made during the summer of 1914 by Leonard Lundgren, Hydro-electrical Engineer, U. S. Forest Service, accompanied by Supervisor W. G. Weigle, of the Tongass National Forest. The trip covered Ketchikan, Wrangell, Sitka, and Juneau Mining Districts. Most of the important power sites, developed and undeveloped, were visited.

Additional information has been secured thru correspondence, so that the water power situation is shown to October 1, 1915. Acknowledgement is made to the various companies mentioned herein, without whose coöperation much valuable data could not have been obtained.

Publications and Written Reports

Publications on Alaska issued by the United States Government are too numerous to list here. In addition to this information, the writer had access to the correspondence files of the U. S. Forest Service and to the following written reports:

A Water Power Reconnaissance in Southeastern Alaska, by John C. Hoyt, U. S. G. S., 1909.

Water Power Conditions in Southeastern Alaska, by P. H. Dater, U. S. F. S., October, 1913.

The Speel River Project, by P. H. Dater, U. S. F. S., November, 1913.

The Warm Springs, Shrimp Bay, Fish Creek, and Mill Creek Projects, by Leonard Lundgren, U. S. F. S., October, 1914.

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*Class of 1904. District Engineer, United States Forest Service, Portland, Oregon.

The Carlson Creek Project, Alaska Gastineau Mining Company, by Leonard Lundgren, U. S. F. S., November, 1914.

The Chichagoff Power Project, Chichagoff Mining Company, by Leonard Lundgren, U. S. F. S., December, 1914.

The Suloia Bay Project, George E. James Company, by Leonard Lundgren, U. S. F. S., April, 1915.

The Lake Whitman Project, New England Fish Company, by Leonard Lundgren, U. S. F. S., April, 1915.

The Annex Creek Project, Alaska Gastineau Mining Company, by Leonard Lundgren, U. S. F. S., May, 1915.

The Rhine and Grindstone Creeks Project, F. B. Hyder, et al., by Leonard Lundgren, U. S. F. S., July, 1915.

Maps

The topographic maps of this region, published by the Geological Survey, are as follows:

540-A The Kassan Peninsula, contour interval 50 ft. (1 :62,5000).

540-B Copper Mountain, contour interval, 100 ft. (1 :62,500).

581-A Juneau, contour interval 100 ft. (1 :62,500).

581-B Berners Bay, contour interval 50 ft. (1 :62,500).

581-C Eagle River Region, contour interval 50 ft. (1 :62,500).

Most of the coastline has been surveyed by the Coast and Geodetic Survey and detail maps issued. There are also numerous unpublished maps in the files of the Forest Service.

Appendix B contains a general map of Alaska and several detail maps showing the location of the projects discussed herein.

Historical Sketch

Alaska derives its name from an English corruption of the native word "Al-ay-ak-sa," probably meaning "The great land" or "Mainland."

The first reported exploration of the region now known as Alaska was by the Russian officers Bering and Cherikov in 1741. Russian traders and trappers arrived soon after, and their activities interested other nations in Alaska. Spanish expeditions visited the southeastern shore, now commonly known as the

"Panhandle," in 1774 and 1775, and Captain Cook surveyed the coast for the British Government in 1778. The first settlement was made by the Russians at Three Saints on Kodiak Island in 1784, and the Russian-American Co. founded Sitka in 1804, which was the seat of government until 1906, when Juneau was made the capital. The formal transfer, however, did not take place until 1912.

In 1821 Russia attempted to exclude foreign navigators from Bering Sea and the Pacific Coast of her possessions, which caused a controversy with the United States and Great Britain. The question was settled by a treaty with the United States in 1824 and one with Great Britain in 1825, by which the boundaries of the Russian possessions in America were permanently fixed.

In March, 1867, Alaska was purchased by the United States for the sum of $7,200,000 in gold, and in October of the same year the formal transfer was made at Sitka. From 1867 to 1877 Alaska was governed thru the War Department, altho the customs were from the beginning collected by the Treasury Department, and with the latter the control rested from 1877 until the passage of the act of 1884. This act extended over Alaska the laws of the State of Oregon so far as they were applicable, created a judicial district and a land district, put in force the mining laws of the United States, and gave the country an administrative system.

The influx of settlers after the discovery of gold in the Klondike in 1896 rendered more adequate laws necessary. In 1899 and 1900 Congress made provision for a code of civil and criminal law, and in 1903 passed a homestead act. In the meantime a serious boundary controversy arose between the United States and Canada regarding the interpretation of the treaty of 1825. This was settled in 1903 by an agreement whereby the sea coast of Canada extended no further north than 64 degrees 40 min. The Act of August 24, 1912, organized Alaska into a territory and all the laws thereof applied to the new territory.

The Chugach National Forest was created December 24, 1892, by the President of the United States thru the power conferred on him by the Act of March 3, 1891. Successive

boundary changes have been made. Its present area is 5,817,959 acres, with an estimated stand of 8,000,000 board feet of timber. The Tongass National Forest was similarly created August 20, 1902. It now has an area of 15,480,986 acreas, and 70 billion board feet of timber.

Population

The population of Alaska, according to the census of 1910, was 64,356, as compared with 63,592 in 1900. In 1910 35,347 were whites and 29,009 were Indians and others. Southeastern Alaska in 1910 had over 15,000 inhabitants divided as follows:

Juneau District	5,854
Ketchikan District	3,520
Sitka District	2,210
Skagway District	1,980
Wrangell District	1,652
Total	15,216

These figures show the distribution of the people and indicate how sparsely the country is settled.

General

The "Panhandle" is 380 by 120 miles in extent, most of which lies in the Tongass National Forest. It has the same latitude as southern Norway and resembles that country in a marked degree. As a rule the mountains rise abruptly from the shore, at altitudes ranging from 4,000 to 7,000 feet, leaving few areas suitable for agriculture. The mainland and the adjacent islands form a series of deep sheltered waterways suitable for ocean-going steamers. Regular lines of steamers ply between Seattle and Alaska. The stops at canneries and mines during the summer season make the voyage of special interest to the tourist. Local service is given by smaller steamers. Under these conditions few roads would be required even if the topography permitted. In the "Panhandle" it is probable there are not more than four or five wagon roads, of which only two exceed ten miles in length.

Many lakes are situated close to salt water and empty into the ocean with a cascade or a series of rapids. As the streams are in flood during the summer, the value of the water

power resources has been generally overestimated. This fact is borne out by the excessive installations in some of the completer power plants. Two rivers, the Stikine near Wrangell, and the Taku near Juneau, break through the Coast Range from Canada. These streams have no water power possibilities in American territory.

Geology

Southeastern Alaska is said to be new geologically. The formation of the islands and mainland up to the foothills is limestone, slate and schist. The balance is granite. Alluvial flats and glacier deposits are found at the outlet of rivers, but elsewhere the coast is rocky and steep. In general, there is very little soil cover over the bed rock. This usually consists of highly inflammable material, such as moss, leaves and partially decayed vegetable matter.

The Juneau gold belt and the Porcupine gold-placer district are famous for gold production, and some auriferous veins are known in the Ketchikan copper district. Iron ore is also found with the copper in the Ketchikan district and as distinct ore bodies near Haines. Silver-bearing galena lodes are known to exist in the Ketchikan and Wrangell districts. Gold lodes and some gypsum occur in the Sitka district. Marble is widely distributed and is quarried in the Wrangell and Ketchikan districts. Garnets and barite are found in the Wrangell district. On Admiralty and Kupreanof Islands are some small areas of lignite-bearing rock. Several hot springs are known and are used for medicinal purposes.

Climate

The climate is similar to that of the Western part of Oregon and Washington. The first frosts generally occur in September, and the last frosts seldom occur later than the first of May. The number of growing days averages about 180 during the year. The winter temperature ranges from 10 to 20 degrees above zero, and the summer temperature ranges from 70 to 80 degrees, with occasional extremes up to 90 degrees. These records apply to sea level elevations only. No records are available for higher altitudes. The precipitation varies considerably, not only in the different sections of the "Panhandle," but also on

Miles Canyon, Lewis River.

adjacent watersheds. Along the west coast and Dixon Entrance, because of the direct winds of the Pacific, the rainfall is high, ranging from 162 inches a year at Ketchikan to 85 inches at Sitka. In passing inland it decreases, and at Skagway is only 23 inches. A disagreeable feature of the country, and of vital importance during construction, is the large number of rainy days throughout the working season. Generally the rains are gentle, falling mostly in the form of mist.

Agriculture

The vegetation in Southern Alaska is rank and luxuriant, in spite of the thin soil cover. This is due to the peculiar climate caused by the Japan current. Where nature affords the slightest foothold, a heavy growth of spruce, cedar and hemlock is found, with dense masses of devil's club, ferns and other undergrowth. The forests are practically in their primeval condition and contain many over-mature and defective trees. Trees are found having diameters up to six feet. Lumbering operations as now practiced take only the perfect logs, leaving the over-mature and defective growth to shade the ground, which prevents good silvicultural conditions. The total amount of timber cut on the Tongass Forest during the year 1914 was over 42 million board feet. This was practically all consumed by the local mining and canning industries.

About one hundred homesteads have been taken up in the "Panhandle," but it is doubtful if all the claimants will desire to "prove up" when the agricultural and living conditions have been ascertained. Garden truck, berries, the hardy grasses and grains can be raised wherever tillable land is found. Owing to the summer and autumn rains, the grasses and grains are difficult to harvest and cure. Experience indicates that the American is unwilling to engage in this work, and most of the agriculture is now performed by Japanese and uneducated Europeans.

Industries

The principal industries in Alaska are mining, fishing and lumbering. The total mineral output during the year 1914 was valued at $19,118,000, of which $15,764,000 was gold. The total investment in fisheries in 1914 was over $37,000,000, and the value of the products was over $21,000,000. This industry em-

ployed 22,000 people, which is about one-third of the entire population of the Territory. The timber cut throughout Alaska during 1914 totaled approximately 50,000 board feet. This was not sufficient to supply the local demand, and large quantities of lumber were imported.

These industries build water power plants if sites can be found conveniently situated, and many sites are now being investigated prior to construction. One permittee of the Forest Service is actively engaged in promoting an electro-chemical project which, if successfully developed, will be the largest factory of its kind in the West. The Tongass National Forest contains a stand of 70 billion board feet of virgin timber that is suitable for the manufacture of paper. Every effort is being made by the Forest Service to have this valuable resource utilized.

HYDRAULICS.

Definition of Terms

The volume of water flowing in a stream—the run-off or discharge—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups: (1) those which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and discharge in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off (depth in inches) and acre-feet. The terms used herein are second-feet, second-feet per square mile, run-off (depth in inches), and acre-feet. They are defined as follows:

"Second-foot" is an abbreviation for cubic feet per second and is the unit for the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors in the following table of equivalents.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off" (depth in inches) is the depth to which the drainage area would be covered if all the water flowing from it in a

Large Sitka Spruce.

given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

An "acre-foot" is equivalent to 43,560 cubic feet and is the quantity required to cover an acre to the depth of 1 foot. The term is commonly used in connection with storage for irrigation work.

"Nominal stream flow" is the quantity used by the Government in determining the power capacity of water power sites. It is defined as the average of the values estimated for the natural flow for the two-month (calendar) minimum flow period in each successive five-year period or major fraction thereof.

Convenient Equivalents.

The following is a list of convenient equivalents for use in hydraulic computations:

1 second-foot equals 40 California miner's inches (law of March 23, 1901).

1 second-foot equals 38.4 Colorado miner's inches.

1 second-foot equals 40 Arizona miner's inches.

1 second-foot equals 7.48 United States gallons per second.

1 acre equals 43,560 square feet.

1 acre equals 209 feet square, nearly.

1 cubic foot of water weighs 62.5 pounds.

1 horsepower equals 550 foot-pounds per second.

1 horsepower equals 1 second-foot falling 8.80 feet.

1 horsepower equals 746 watts.

1 1/3 horsepower equals 1 kilowatt.

To calculate water power quickly: Second-feet times fall in feet times .08 equals net horsepower in a hydro-electrical plant realizing 70 per cent of theoretical power.

Stream Flow.

The run-off in the "Panhandle" is subject to wide variation. Drainage areas are relatively small and precipitous. During the winter the ground is frozen, and, due to the solid bed rock formation, there is no appreciable amount of subterranean water to maintain the stream flow. Consequently the low-flow season is of long duration, extending from January to April, inclusive. Many

streams have natural storage in the form of lakes and show a greater flow during the winter period than others.

Stream flow records are very limited. Up to the past year scarcely any measurements had been made except near Juneau. These are available for the confidential information of the Government, but the owners do not wish them published at present. It appears that streams heading in lakes average from 1 to 3 second-feet per square mile during the two months low-flow period. Other streams average from ½ to 2 second-feet per square mile during the two months low-flow period. The average discharge for the year is from eight to twelve times the average flow for the lowest month. Stream flow records in this region are viewed with distrust by engineers not familiar with local conditions, because the run-off appears greater than the precipitation. This is due to the enormous increase of rainfall at elevations above sea level, where no records are available.

The insufficiency of private records has led to a co-operative agreement between the Forest Service and the Geological Survey to secure additional stream flow measurements. Eight automatic gaging stations were established during the summer of 1915 to supplement the data now being secured in the vicinity of Juneau by private interests. This work should assist in the development of local resources.

Water Rights.

Water rights may be secured in Alaska by posting a notice at the proposed point of diversion and filing a copy in the office of the District Recorder of the district wherein the development is to be made.

Power Permits.

The Secretary of Agriculture has authority to grant water power permits within the National Forests under the Act of February 15, 1901. Information may be secured and applications filed either with the Forest Supervisor at Ketchikan, Alaska, or with the District Forester, U. S. Forest Service, Portland, Oregon.

The lands outside of the National Forests are under the jurisdiction of the Department of the Interior. Applications for this land should be filed with the local land office at Juneau.

Western Hemlock Forest in Southwestern Alaska.

Developed Water Powers

The rated water wheel capacities of plants in Southeastern Alaska to December 31, 1915, are 32,000 horse power, distributed as follows:

Ketchikan Region, 4,100 hp.

- Citizens Light, Power & Water Co. . . . . 2,000 hp.
- New England Fish Company . . . . 1,100 hp.
- Miscellaneous plants . . . . *1,000 hp.

Wrangell Region, *200 hp.

Sitka Region, 1,000 hp.

- Sitka Warf and Power Company . . . . 300 hp.
- Chichagoff Mining Company . . . . 500 hp.
- Miscellaneous plants . . . . *200 hp.

Juneau Region, 26,500 hp.

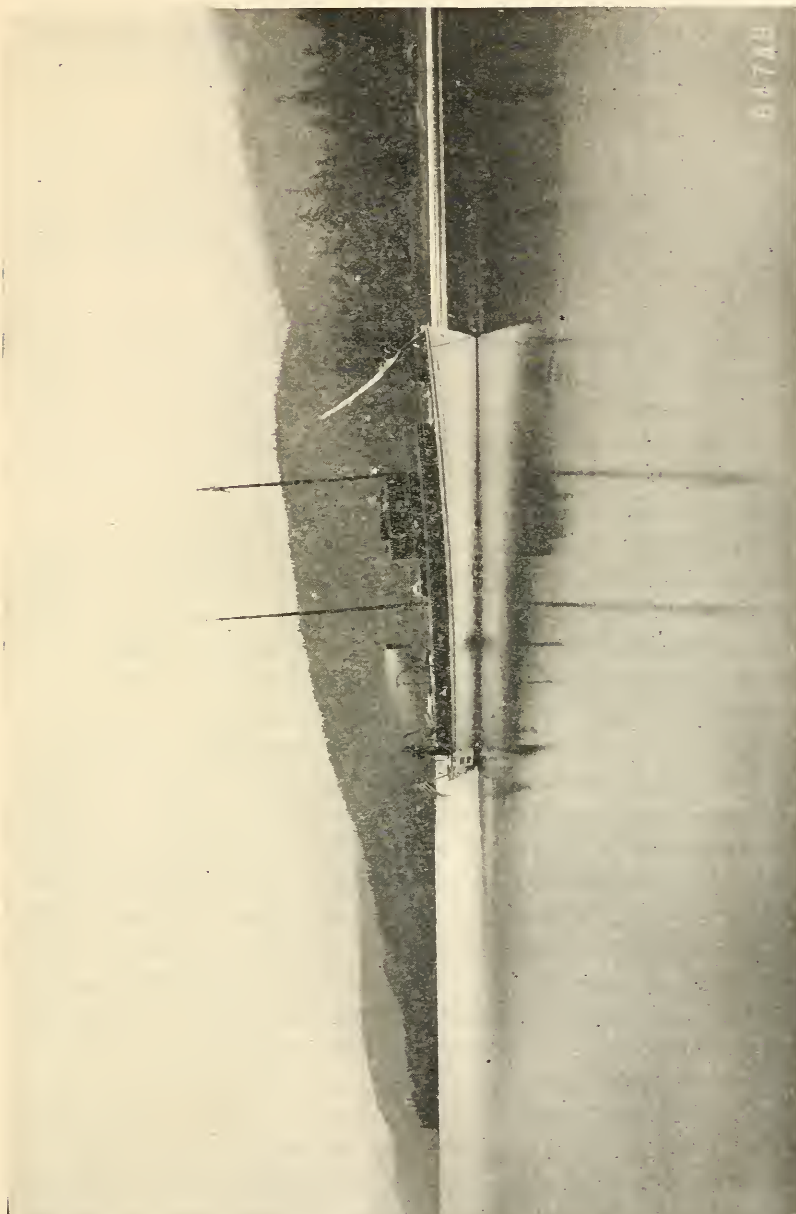
- Alaska Treadwell Mining Company . . . . 13,500 hp.
  - Douglas Island Plant . . . . 4,000 hp.
  - Sheep Creew Plant . . . . 3,800 hp.
  - Nugget Creek Plant . . . . 5,700 hp.
- Alaska Gastineau Mining Company . . . . 10,000 hp.
  - Salmon Creek Plant No. 1 . . . . 4,000 hp.
  - Salmon Creek Plant No. 2 . . . . 2,000 hp.
  - †Annex Creek Plant . . . . 4,000 hp.
- Alaska Electric Light and Power Co. . . . . 1,000 hp.
- Miscellaneous plants . . . . *2,000 hp.

Skagway Region, *200 hp.

*Small plants operated intermittently, mostly by mines, canneries and sawmills.

†Under construction October 1, 1915—probable completion December, 1915.

The special water power census taken by the U. S. Census Bureau in 1908 shows a total of 16,000 hp. This indicates that the power devolopment has doubled in seven years. In so far as several of the plants shown in the census of 1908 have been scrapped and as a number were included that were not located in the "Panhandle," the actual growth is greater than indicated. The population, according to the census of 1910, is 15,216, which gives a water wheel rating per capita of over two horse power. This is an interesting fact, since no higher per capita water power development is known in any area of equal size in the world.



Forest Service Launch "Tahn," Used by the Author in Making His Reconnoissance.

THE MANUFACTURE OF SULPHITE CELLULOSE BY THE RITTER KELLNER PROCESS

BY C. C. HERITAGE*

In this first of a series of three articles Mr. Heritage reviews briefly the entire process of cellulose manufacture. In his following articles Mr. Heritage will carefully consider each unit as given in this first article. This article is well worth reading and contains a great deal of practical information of interest to all of our readers.—The Editors.

In presenting a subject of this nature for the consideration of engineers who are perhaps unfamiliar with any of the processes for obtaining cellulose, and but little more so with the product itself as such, it will be necessary briefly to go into the raw material with which the cellulose mill works, the various processes by which the raw material may be changed, and the nature and importance of the product obtained.

Cellulose is a constituent part of all the higher plants in the botanical world, and since the constituents not cellulosic can be removed by the proper chemical treatment, in practically every case, it follows that the possibilities of producing cellulose are almost limitless from a purely chemical standpoint. From the engineering viewpoint, however, the economical production of cellulose is not feasible in a great majority of these possibilities, and as long as the condition of over-production obtains in this industry as at present, the situation will remain the same. Grasses of many varieties, and higher species like the sunflower and maize show excellent fibre on proper treatment, but the cost of marketing, storage, processing and most important, the low yield makes the proposition impossible in the present market. The above is not meant to convey the idea that all grasses or plants of which the stalk is a considerable per cent are not worked up at the present time. The Esparto of Northern Africa is a most notable exception and forms a large per cent of the furnish of many continental papers.

In wood we find combined the favorable factors—a large, though not limitless supply by any means, a natural growth giving a large yield per unit of area and a consequent low figure

*Class of 1914. Chief Chemist, Nehassa Edward Paper Co., Port Edwards, Wis.

for marketing, handling and storing, and a good though not high yield of cellulose. Wood, therefore, takes its place as the principal raw material for the manufacture of pulp.

Just any wood will not make good pulp, and hence the necessity of understanding the factors which show a wood to be suitable or not. It is difficult to tabulate these factors in any order of importance for they are all equally important. They are as follows: First, a high per cent of cellulose; second, a low per cent of lignin; third, a low per cent of pitch or resin; fourth, a good fibre length in the resulting pulp; fifth, a fibre or cell wall of good thickness; sixth, a reasonable straight grain with absence of knots; seventh, the absence of large quantities of coloring matter; eighth, a bark which will yield to reasonable mechanical treatment; ninth, a correct density of structure.

In regard to the first factor, let us consider with what we are dealing. In the forming of the woody structure, the skeleton of cellulose fibres which are colloidal in nature take up soluble products from the sap and by a process of adsorption become incrusted. This incrustation may or may not be considered an integral chemical part of the cellulose fibre, but be that as it may, its function is the cementing together in one coherent mass the numberless fibres and vessels to produce the wood structure. This incrustation is termed lignin and together with the fibre itself is called the ligno-cellulose complex.

The object of our process then is to remove this cementing material as easily and completely as possible with the least injury to the cellulose itself, and thus free the fibres in their natural form and strength. The chemical characteristics of the two bodies lignin and cellulose favor this resolution, else the reaction would be impossible. In cellulose we have a carbohydrate of great complexity whose constitution is unknown, of empirical formula X $(C_6 H_{10} O_5)$ and closely related to starch. We may, therefore, say that the ultimate groups of the cellulose molecule are saturated derivitives of polyhydric alcohols with no doubly linked carbon atoms present, and the whole group is therefore non-reactive to all reagents, except a few of high intensity. On the other hand, lignin is a complex, containing acid and unsatured ketonic groups which yield comparatively easily to chemical treatment, forming soluble bodies which make up the main bulk

of the waste liquor from any cooking process. Lignin has the empirical formula ($C_6 H_6 O_3$) and having fewer OH groups than cellulose is more easily hydrolysed. The presence of carbonyl groups make possible the attack of the bisulphites, and the low oxygen content shows it to be an easily oxidizable body. Lignin may then be described, chemically as an unsaturated cyclic compound reacting by addition, hydrolysis or oxidation.

We will digress long enough at this point to touch very briefly on the various means employed to put the lignin into solution and resolve the cellulose. The processes are termed sulphite, sulphate and soda. All these have the following points in common. The wood is barked, chipped and filled into large containers, where it is subjected to the action of the cooking liquor for various periods, at various pressures and temperatures. The cooking liquor is the essential point of difference in the above named processes. In the sulphite process the liquor is acid in character, being a solution of the bisulphites of calcium and magnesium with as high a percentage of free sulphurous acid as is possible. In the sulphate process, the liquor is a rather complex solution of sodium salts approximately as follows:

Sodium Sulphate	37%
Caustic Soda	24%
Sodium Sulphide	28%
Sodium Carbonate	10%
Sodium Acetate	1%

In the Soda process the liquor consists of a solution of caustic soda alone of a gravity of about 20° Twaddle. In both of these latter processes the waste liquor is treated to recover and regenerate the sodium salts. Because of the very large volume of this liquor, special installations are made of multiple effect evaporators and special inceneraters which later combust the organic matter and turn out a dark impure sodium carbonate which is recausticised with lime.

The sulphite process is the more important of the three, while the soda process is least used. The sulphate process is constantly gaining ground, due to the high demand for high-grade genuine kraft pulp, which considerably exceeds the strength of the sulphite product. Another reason is also apparent in this connection when increasing scarcity of coniferous woods is noted.

Many woods incapable of reduction to pulp by the sulphite process, more especially deciduous woods such as poplar are easily processed by sulphate.

Returning now to a consideration of the various factors in the choice of a wood, the importance of the first factor mentioned, a high content of cellulose, need not be discussed. A yield of less than 35% cellulose would certainly make a species valueless for pulp manufacture. The figure commonly attained ranges between 40 and 55 per cent air dry fibre.

The second factor a low percentage of lignin hinges more or less on a high percentage of cellulose. It is also very important in that it governs the amount of chemicals necessary and the time and severity of treatment. An average figure for lignin content is 35% to 40%.

A low percentage of pith or resin is essential, especially when the treatment is sulphite. These materials are quite easily removed in the waste liquor under alkaline treatment, but by sulphite digestion reliable data shows less than 5% of these bodies originally present in the wood, removed. If the pulp is not very carefully handled subsequent to digestion this pitch content causes no end of trouble at every stage of manufacture through to the ultimate sheet of paper. Spruce and hemlock show about .75% of these bodies, which is an allowable figure.

The fourth point, that of fibre length in the resultant pulp, is one of the chief factors bearing on the strength of the finished sheet of paper. A sheet as it is formed is felted, that is, the fibres are made to interlace and this interlacing can be accomplished to the desired extent only if the fibre length is right. This physical characteristic averages 3mm. for coniferous trees and 1 mm. for deciduous trees. The latter figure should be considered a minimum.

A cell or fibre wall of good thickness is essential, especially in pulp, which is to be bleached, for the bleaching reaction will weaken any fibre to an extent depending on the severity of the treatment. Then even though the pulp is to be used unbleached the further processing of the material in the paper mill through beaters, jordans, and screens is all conducive to rupture and the stronger the fibre wall in the pulp the better are the chances that the ultimate fibre will retain its integrity in the sheet of paper.

The sixth factor is one of both chemical and mechanical importance. Mechanically a straight grain means straight logs, which in turn makes for ease of handling, sawing and more particularily barking, although claims are made for new barking processes whereby crooked pieces are as easily barked as straight ones. Aside from causing inconvenience in handling and cleaning, knots are of a different density and composition than the wood proper, and hence are often left more or less intact in the digesting process. This necessitates a special device for removing these from the cooked pulp with resultant dimunition in yield of good fibre. These knots removed should not constitute more than 1½% of the pulp marketed.

A dark colored wood will make a dark colored pulp in spite of any chemical treatment outside of intensive bleaching. A sample of spruce pulp may be differentiated from hemlock with ease on color inspection only, unless the spruce has been very badly handled in digestion; and in these days when so many natural color sheets are used, this element of color absolutely must be considered and every effort made to secure wood with as little initial color as possible.

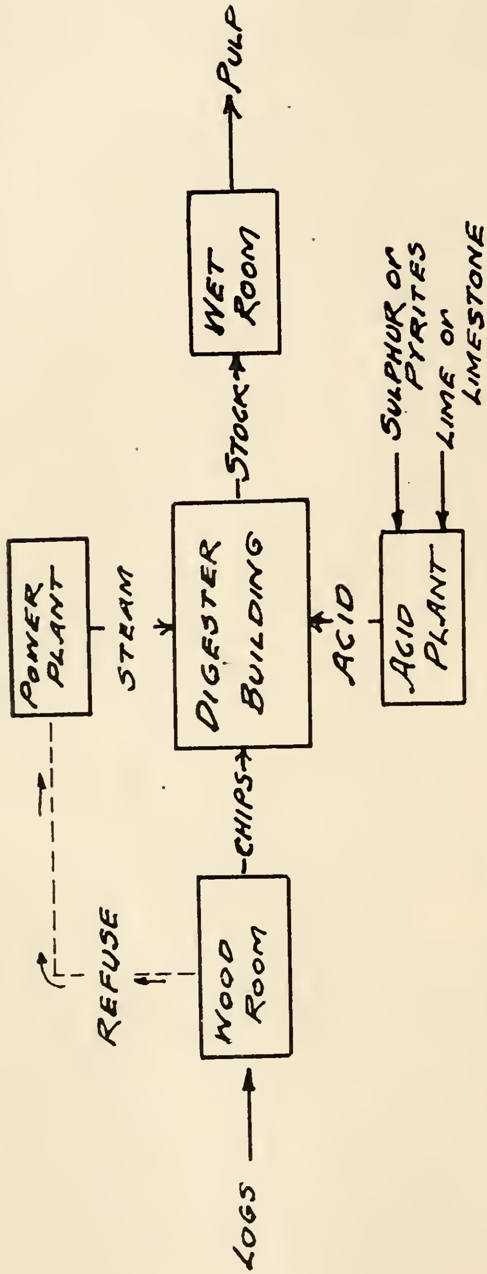
The importance of the eighth point regarding bark will be understood when it is considered that every particle of dirt or dark colored foreign matter of a friable nature such as bark must be kept out of the chipped wood, for every such particle entering the digesters disintergrates into a hundred tiny specks, each of which shows up in the finished sheet of paper as "dirt." Each stick must be carefully cleaned of *all* bark particles, which operation becomes at once tedious and costly.

The last factor in a pulpwood and one of the most important is the density, depending upon the rate of growth of the tree. A very dense wood stays green on long storage, drying out very slowly and consequently absorbing the cooking liquor when in the form of chips in the digester with the same tardiness. The denser the wood the more power is demanded by the machinery of the wood room to reduce the logs to chips and consequently repairs and labor are higher. There is one point in favor of a dense wood which quite outweighs these last mentioned drawbacks and that is the proposition of yield. The more dense the wood, the greater weight of wood is purchased per cord and consequently the greater yield of cellulose per cord.

We will now turn our attention to the sulphite process with which this article deals primarily and consider it in a general way first, before going into details.

Sulphite pulp is marketed either as slow cook, Mitscherlich pulp, or as a quick cook, Ritter Kellner. There is, however, no sharp line of difference between the two as far as time is concerned for it would undoubtedly be possible to find mills cooking any time period from five hours to forty-eight hours or even more. The essential difference does appear in the fact that Ritter Kellner cooking is done with direct steam, while Mitscherlich is cooked indirectly by means of steam coils inside the digester. In the cooking operation there are three fundamental variables—time, temperature and pressure, all interdependent. In the Mitscherlich cook the time is long, the temperature and pressure are both held low, and the resulting pulp is exceptionally strong and light colored. In the Ritter-Kellner cook, the introduction of live steam rapidly progresses until the desired pressure is reached, which may be anywhere from sixty to one hundred pounds, according to individual mill practise; and the resulting high temperature carries the decomposition of the lignin to completion in from five to ten hours, depending on various factors, such as condition of the wood, size of the digester, strength of the cooking acid, etc. This method of cooking is very flexible, for it is possible to produce a soft, easy bleaching stock one day and a hard, tough, very strong, unbleachable stock the next if desired.

A general idea of the layout of the Ritter-Kellner mill with the movement of material may be gained from figure one. The logs after having been seasoned in the open air for a year or more enter the wood room and are here reduced to clean uniform chips, which are delivered to chip storage bins located over the digesters, which thus feed to the digesters by gravity. The refuse from the wood room, consisting of sawdust, small chips and bark, is collected in a system of conveyors and transmitted to the boiler room, where a bank of boilers work on this material all the time. These settings are enlarged at the firing end after the fashion of a Dutch oven, but the combustion of "hog" as this refuse is commonly termed is far from being a perfect and easily controlled process and much solid charred material is showered about in the vicinity of the mill, unburned.



DIAGRAMATIC LAYOUT OF SULPHITE MILL

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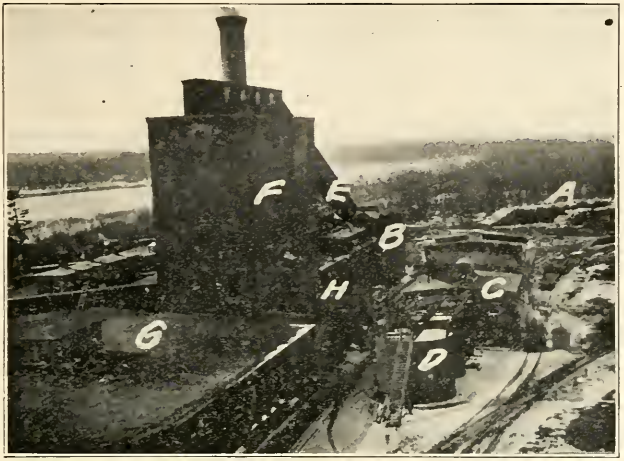
FIG. I

Two systems are in common use for manufacturing the cooking acid, one utilizing milk of lime, the absorption of gas taking place in a system of tanks, and the other utilizing limestone with the absorption taking place in immense towers. The Stebbins modification of the milk of lime system will be the one to which we shall turn our attention later in the article. The acid plant then furnishes the cooking acid to the digesters.



The digesters receiving steam, acid and chips, turn out the crude cellulose fibre as a thick suspension in the exhausted cooking liquor, which is now known as stock. It is discharged to the blowpits, where the fibre is thoroughly washed. It is then further conveyed by pumps and pipelines over cleaning and sizing devices to the so-called wet machines, where the finished product is removed in "laps," of approximately fifty pounds each, with a moisture content of about 65%. Many mills pass the sheet of pulp through a long drying machine so that instead of the finished product being a wet folded lap, it is an air dry sheet and can therefore be shipped to a far distant point at no excessive freight charges. Plate I shows a compact arrangement of buildings in a sulphite mill. The following are the notations:

A Wood Storage.
B Wood Room.
C Acid Plant.
D Acid Storage Tanks.
E Chip Elevator from wood room to Chip Bins above digesters.
F Digester Building.
G Wet Room and Shipping room.
H Relief Counter Current Coolers.

A MODERN BERLIN DEPARMENT STORE

BY JACOB H. BISCHOF*

It is generally conceded that as far as the architecture of commercial buildings is concerned, no country has made such rapid progress as has Germany in the last ten years. This is, of course, excepting the skyscraper which is a problem peculiar to America and is likely to be so for some time to come. The Art Nouveau movement in Germany has been more successful in respect to the business buildings than to any other type, and has proven to be so logical, and effective in its bold beauty and simple impressiveness, that of late its influence has been felt in America, not only in interior decoration, advertisement posters and color schemes, but in our very buildings themselves. Although the American skyscraper office building is unknown in Europe, there remains the department store type to be compared, and in many ways the German department store—warenhaus—is similar to our American institution.

In other countries the principal requirements of the department store are space for display and selling, adequate light and ease of communication with different departments. In the case of display, our department stores aim at every available inch of glass area facing the streets. And to gain this end the ground floor piers are reduced to a minimum, thereby obtaining a continuous display section, but often leaving the impression that the entire masonry construction above rests on plate glass. In the German department store each window is used for a separate display and is treated as a unit. The piers are not narrowed at the ground floor, but they line up with those above and appear to support the superstructure in a perfectly natural manner. This generosity of the store owner in sacrificing some of his most valuable display space in order to improve the design is something that one seldom encounters here, and is hardly to be expected, considering the value of down-town real estate.

In the largest American department stores the plans provide for a wide passage way running the entire length of the

*Class of 1913. With Howard Van Doren Shaw, Architect, 720 Mentor Bldg., Chicago, Ill.

building, forming the principal artery of circulation, while perpendicular and parallel to this run minor aisles, separating the different department—in most cases no flor space is sacrificed for light courts. The German architect is not satisfied with such a general solution of so complicated a problem. Instead, he attempts to emphasize the various parts of the composition according to their importance; and so we find each department housed in a separate section especially designed for it—and with means of easily attracting visitors to it.

In Berlin it is impossible after entering a store to walk down a straight corridor leading to a street exit at the extreme end. But before we have gone many steps we come into a large light court, and from here the principal passage ways lead to the important departments surrounding the court, or even to other courts with their groups of encircling shops. These light courts extend up through the entire building, and from them one may obtain general views of a large portion of the departments of the store—and from here also are visible the stairs and elevators. Thus a court proves a most practical arrangement in that it serves as a guide, relieves the congestion due to the movement of large crowds of people, and provides an unexcelled lighting arrangement. So the court becomes the feature of the plan—the nucleus about which are grouped the different departments according to their importance.

To get a more definite idea of this type of building, let us consider the Wertheim store—the finest warenhaus in Berlin. Here one-fifth of the floor area is occupied by light courts; but the architect has taken complete advantage of his opportunities for monumental designs—and money is lavished upon expensive materials and "features" that are regarded as extravagances by most of our merchant princes. The Werthein store has, in addition to the three principal light courts, a luxurious winter garden on the main floor, the only purpose of which is to provide a resting place or rendezvous for the visitors; an open-air summer garden, where the atmosphere of the cloisters of the Certosa da Pavia is cleverly suggested with its archaic terra-cotta fountain and excellent wrought iron grilles; and a large section on the second floor, where railway, steamboat and theatre tickets are sold at box office prices. These, in addition to the well-equipped

restaurants, cafeteria and tea rooms serve to show how liberally the Berlin merchant provides for the comforts of his guests.

Wertheim's covers a great area, but is only six stori s hig'ı. It is easily seen that the building is a product of gradua' growth, each new addition being made as the necessity arose. Architecturally, the most interesting part is that facing Leipziger Platz, built from the designs of Alfred Messel. Most of Messel's work is of such high standard that it is difficu't to single out a y particular item for distinction. The great light court—Ma mor

The Wertheim Store.

Lichthof—is surrounded by mighty piers of oyster gray marble, five stories high, which are connected with elliptical arches at the top—and the court is spanned by a tremendous glass ceiling light built in a segmental bronze frame. At the level of the fifth story ceiling, two huge arches—faced with bronze and richly paneled and coffered—form bridges across the court and from these are hung festoons of electric lights from which at intervals drop elaborate bronze fixtures. The whole effect is a splen-

dor almost oriental in its lavishness and color, but with the dignity and restraint of the classic.

Not far from the Marble court is the Winter garden—a square room admirably adapted from the Italian Renaissance. The wall openings are flanked with marble pilasters in which are inserted bronze reliefs. Again we have an elaborate ceiling light through which pours real sunshine upon the mound of palms, ferns and blue and white hydrangeas—which forms the central feature of the room—and which is surrounded by chairs, lounges and writing tables.

The Candy room is an excellent example of design and materials uniting to express the nature of its wares. The entire room is done in light tan iridescent terra-cotta—from the Karlsruhe kilns—and throughout the details are of flower and fruit designs. Even the elaborate lighting fixtures are of the same terra-cotta; and the chief impression we gain from this remarkable room is that it is built of the same candies that tempt one in the glass cases.

The Rug room which occupies two stories in height is another example of erecting a well-defined setting in which to display the merchandise most artistically. Here we find decoration that seems as much a part of the East as do the Persian rugs that we come to buy. Built entirely of a rose-tinted Italian nutwood, and with a richly painted beamed ceiling, it stands a monument to the altruistic spirit of the proprietor who was willing to sacrifice valuable space, and spend much money, with nothing to gain but a beautiful effect.

And so down the entire list of shops—for this warenhaus is more a collection of individual shops than the decidedly monotonous series of counters that our department stores present—we find an attempt made to design each section with a regard to the nature of the merchandise which is to occupy it; and to plan everything for the comfort of the visitors. Nor does the proprietor's responsibility end with his customers' ease—for on the roof we find an attractive recreation garden, where his employes may rest amid growing grass and trees.

The exterior is no less interesting than is the interior, and surely there is no better designed facade in Berlin than the one facing Leipziger Platz. Here we have an exceedingly individual

design, daring, original and beautiful, possessing much of the virility and charm of the Lombardy Romanesque. Back of the arches is the entrance loggia with walls and barrel vault of

Fig. 2. The Rug Room, Wertheim.

stone. Along the walls are rows of box-trees, and terminating the view is an interesting wall fountain. Above this loggia is the two-

storied Rug room, and here Messel uses the stone piers and mullions to produce an astonishing vertical movement, which unfortunately is hastily terminated by the heavy roof. This type of roof seems to be a necessity to every German commercial building—though as far as practibility is concerned it has no reason for being, except for a certain picturesqueness which to us is not pleasing. These inevitable roofs occupy from one to two stories in height and have such small dormer windows that they are of little use for storage.

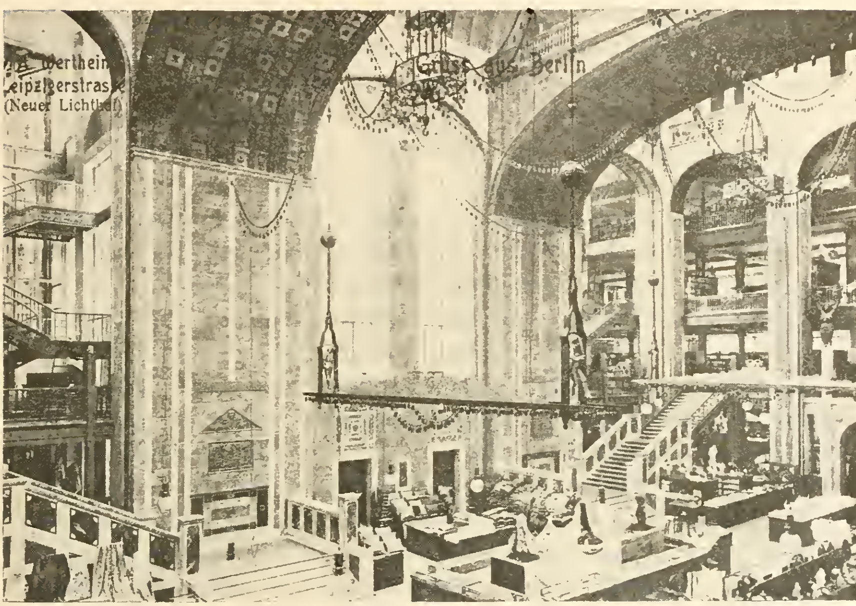


Fig. 3. The Marble Light-Court, Wertheim.

But in spite of its defects, this Berlin department store stands as a three-fold inspiration—to architects, as a logical, original and beautiful solution of a difficult problem; to merchants, as an example of a building being its own advertisement; and to the community, as an indication of the good faith and generosity of a public-spirited business man which enables him to build a practical monument which is unsurpassed in excellence by any cathedral, museum or governmental building in the city.

CHEMICAL CONTROL IN PHARMACEUTICAL MANUFACTURING

BY H. W. JONES*

Of the many industries of this country there is none, perhaps, of which less is known by the outside world than that of pharmaceutical manufacturing; and yet I am sure there are few industries whose products are more widely used. It is also not a matter of general knowledge that these interests run up into millions of dollars, and employ hundreds of chemists and other scientifically trained men who are controlling with the most extreme care the products of their laboratories, devising new processes and products, and improving old ones. In view of the fact that this lack of information exists, it may be of interest to consider the nature of the products of a manufacturing pharmaceutical house, and to take up the chemical control of these products as carried on in the larger factories today.

The chemical control of manufacturing industries is a thing of comparatively recent development and there is no industry which should require more careful control than that of pharmaceutical manufacturing, with its thousands of different products all intended for human use or consumption, many of which contain drugs of great potency. Nevertheless, before the passage of the Federal Food and Drugs Act, which became effective June 30th, 1906, chemical control in pharmaceutical laboratories was a matter of willingness or desire on the part of the manufacturers; and, as might be expected, many products were placed on the market which were very inferior in quality, and in no respect conformed to the statements on their labels. The United States Pharmacopoeia had established standards of strength and purity for drugs and chemicals, which might be conformed with if the manufacturer so desired, but there was no law to compel him to adhere to those standards. The Food and Drugs Act immediately changed the condition of affairs, as it made the Pharmacopoeia a legal standard, to which all manufacturers of medici-

*Class of 1907. Chief Chemist, The Wm. S. Merell Chemical Co., Cincinnati, Ohio.

nal products must conform; and so in a day many factories were confronted by the necessity of standardizing their products or the alternative of prosecution, fine, and consequent loss of prestige.

Although most of these manufacturers already maintained small analytical laboratories, it was now found necessary to enlarge these laboratories and increase the working force in order to accommodate the increased volume of work. Chemists trained in this particular branch were not plentiful, and methods of analysis for many of the products were in a most unsatisfactory state and had to be worked out as the necessity for them arose. For a while the Pharmacopoeia gave standards and assay methods for many of the products. Not a few of these methods were impracticable; nor did they at all cover the field. A large amount of work has been done along this line by both government chemists and the large manufacturing houses, and at present satisfactory methods are available for assaying practically all products.

As this paper is written for the enlightenment of readers unfamiliar with pharmaceutical products, it will be well to say a few words in regard to their nature.

Probably the most important class of these preparations is the class of extracts of vegetable drugs. The extracts may be divided into three classes, viz.: fluid extracts, solid extracts, and powdered extracts. Fluid extracts are made by packing the ground drug in a tall cylindrical apparatus called a percolator and pouring the extracting medium, known as the mentruum, on top of this drug. The menstruum, which in practically all cases is alcohol of such strength as has been found proper, slowly percolates through the drug extracting the soluble principles, and is collected from the bottom of the percolator, which narrows down to a small opening. When the drug is exhausted the percolate is evaporated and the volume so adjusted that one liter of extract represents one kilogram of of the drug.

To obtain a solid extract all of the alcohol and most of the water is distilled from the percolate, leaving a viscous mass which is usually about four times the strength of the drug; while for a powdered extract the percolate is evaporated to complete

dryness, the hard mass powdered in ball-mills, and diluted to the same strength as the solid extract by the addition of starch, milk-sugar, or other inert material.

Another class of preparations known as tinctures is prepared in a manner similar to that applied to fluid extracts, but tinctures are in general one-tenth the strength of fluid extracts. Other fluid preparations in common use are medicinal syrups, flavoring extracts, medicinal wines and elixirs.

Pills, which are familiar to all, are produced in large quantities by special machinery, and are marketed, as a rule, coated with sugar or gelatin. These are being replaced to a great extent by the well-known compressed tablets, which are made in enormous quantities, both uncoated and sugar-coated.

Besides the above preparations, quantities of ointments, toilet-preparations—such as tooth-pastes, shaving creams, face creams and lotions—effervescent salts, alkaloids, and certain refined chemicals are produced.

This brief resumé will give an idea of the nature of the pharmaceutical manufacturer's products, and their number may be suggested when it is said that one of the largest manufacturers lists 440 different kinds of fluid extracts and 585 different kinds of compressed tablets alone, not to mention various other products.

It is absolutely necessary that each lot of each of these many items should be uniform both in composition and in physical appearance, for if any one should vary more than a small percentage from the stated strength the manufacturer is liable to prosecution under the Foods and Drugs Act. It is the duty of the chemists to secure this uniformity, and to illustrate how this is accomplished a few specific cases will be considered.

Of the class of fluid extracts, a familiar example is the fluid extract of opium, commonly known as laudanum. The standardizations necessary in this case, the results of which must be stated on the label of the finished product, are the percentages of morphine and alcohol. In the first place the crude opium must be assayed according to methods provided by the Pharmacopoeia in order to determine its content of morphine. The fluid extract is then prepared in the factory and its volume adjusted roughly. A Preliminary assay is then made of the ex-

tract, both for its morphine content, and its alcoholic percentage. From these figures the yield can be calculated and the final volume fixed. A dilution is then made according to the chemist's directions which will bring the morphine content to the required figure, and at the same time correct the percentage of alcohol, which must also be kept at the required figure. After this a fluid assay is made for alcohol and morphine to verify the dilution. If this is satisfactory the preparation is released by the analytical department and delivered to the packaging department.

Not all the fluid extracts require this elaborate control, but only those containing assayable principles. On the other hand, all must be standardized as to alcoholic content. These remarks apply as well to the solid and powdered extracts, with the exception, of course, of those containing no alcohol.

Of compressed tablets we may consider the well-known combination of acetanilid, caffeine, and sodium bicarbonate, a mixture which is widely used for the treatment of headaches. First of all these ingredients must be tested by the chemists, upon receipt of the shipments, according to standards given in the Pharmacopoeia. If satisfactory, they are released for factory use, to be drawn upon as needed. When a lot of tablets are made a sample is sent to the analytical department where it is assayed for the important ingredients, acetanilid and caffeine. The tablets are also compared there with standard sample as to size, color, and texture. Where tablets contain undeterminable substances, they are carefully checked as to total and individual weight, and number.

Of the tinctures, the tincture of iodine is more or less familiar, and is required by the Pharmacopoeia to contain in 100 cc. not less than 6.86 grams of iodine and 5 grams of potassium iodide having been tested to assure their conformity to the pharmacopoeial standards, the finished tincture is submitted to the analytical department, where it is assayed for all three ingredients, alcohol, iodine, and potassium iodide.

Only a few ointments are considered as requiring standarization. One of these is the ointment of mercury, commonly known as blue ointment. This is a mixture containing 50% of finely divided mercury, and lard, suet, and mercury oleate.

Here the percentage of mercury is to be determined by the chemist, who also examines the physical appearance to see that no globules of mercury are visible at a certain power of the microscope.

These few examples will show the great amount of work necessary carefully to control the pharmaceutical products; and when it is considered that very few of the thousands of products can be treated in exactly the same way, it is not difficult to see that the work requires a great variety of analytical operations. Unification and simplification of these operations are points upon which pharmaceutical chemists are continually working.

To do this a pharmaceutical training is not absolutely necessary. Chemical operations are much the same, whether they be conducted in a steel plant, a sugar factory, or a pharmaceutical laboratory, and once the fundamentals are learned, the special knowledge may come later. There are many men in this line of work who had no previous knowledge of pharmacy. The knowledge is a help to be sure; but what is far more important is a thorough knowledge of chemistry, inorganic, and, above all, organic. This knowledge the pharmacy student rarely possesses, while the student of chemistry or chemical engineering is, as a rule, much better equipped in this respect, and he has the added knowledge of a mathematical training which enables him to think clearly and logically.

The problems are many and varied. Researches along numerous interesting lines are conducted with the assurance that, with one problem solved, another will appear to take its place. A person, therefore, who is possessed of a good knowledge of chemistry and a manipulative skill will find an interesting field for endeavor in the pharmaceutical laboratory. The chemical engineer should also find a place in these plants, for here arise questions of power, special machinery, stills, evaporators, mills, ovens, and all the other problems common to industrial work.

Let it therefore be borne in mind that the pharmaceutical industries are not by any means open only to the initiated, but that they hold a field where the willing student may find pleasant, interesting and varied employment.

THE CHICAGO BUREAU OF FIRE PREVENTION AND PUBLIC SAFETY

BY JOSEPH B. FINNEGAN*

The destruction of property by fire removes irretrievably more than 200 millions in values every year from the wealth of the nation. The city of Chicago in 1914 lost by fire property worth somewhat more than five and a quarter millions of dollars, and that year was one in which no true conflagration occurred. Assuming for the moment that the alarms and fires were uniformly distributed throughout the year, the Chicago fire department answered forty-one alarms each day of the year. Approximately seventy-one percent of these alarms were for actual fires, so that it may be considered that twenty-nine times every day a condition arose which under some circumstances and in the absence of an efficient organization for the extinction of fire might cause extreme loss of property and even of life. The efficient organization was here. The department fought fires bravely and effectively, overcoming the great handicaps due to faulty construction of buildings and unnecessarily hazardous conditions affecting the contents.

An organization that is to be relied upon to guard the city from destruction by fire must include a large number of men, much apparatus, and must call for large expenditures. The Chicago fire department last year had a total enrollment of approximately two thousand men. The value of the land, buildings and equipment in use by the department was slightly less than three and a half millions, and the expense for the year was nearly two and a half millions, equivalent to about $1.43 for each inhabitant of the city. Inasmuch as the actual destruction of value by fire was approximately $2.18 per capita, the total fire cost, if levied upon every resident of the city would be somewhat more than $3.61 for the year. If the levy were direct,—if it were necessary to collect this amount from every individual of every age as a tax,—it would be considered unendurable. In the indirect form in which the first cost is met, it

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is more likely to escape notice, but careful attention will be well repaid if it can save any important part of the annual cost of over seven and a half millions.

The key to the situation is in the fact that a large proportion of the fires is due to preventable causes. We have, and we must always have, a fire department properly trained and equipped to extinguish fires. We must also have proper organization and equipment to prevent fires and to reduce the probability of spread of fires that can not be prevented. Such an organization is the Chicago Bureau of Fire Prevention and Public Safety.

The bureau exists by authority of a city ordinance passed July 22, 1912, and several amendatory ordinances passed subsequently. The original ordinance was introduced at the suggestion of Mayor Harrison, who had received from several organizations of citizens requests that steps be taken to prevent in Chicago any such shocking loss of life in fires as had occurred here and elsewhere in recent years. It is probable that the pitiable conditions at a fire in a New York shirtwaist factory, the story of which attracted notice throughout the country, had an influence in directing public sentiment to the support of the plan. It seemed wise to provide for a close relationship between the work of the new bureau and that of the fire department proper, while the organization should also include engineers having specific training in fire prevention. The ordinance therefore defines the new bureau as "an executive bureau of the Chicago fire deartment," and makes such stipulations as to its personnel as to fix its relationship to the department.

The law requires that the chief of the bureau shall be one of the assistant fire marshals, selected by the chief of the department. The task of making the selection was an easy one. John C. McDonnell, then fourth assistant fire marshal and department inspector, had made for himself a reputation that marked him as the man above all others for the new and responsible assignment. Subordinate to the chief of the bureau are five engineers, not members of the uniformed force of the fire department, but appointed under civil service rules. The senior engineers of the staff, Mr. E. W. Case and Mr. C. W. Hejda, were appointed soon after the establishment of the bureau, and

rank respectively as fire prevention engineer in charge and deputy fire prevention engineer in charge. Both have had extended experience as fire prevention engineers. The thirty-five inspectors of the bureau are uniformed firemen who are detailed from the list of men who have passed their examinations and are listed as eligible for promotion to the grade of lieutenant. This arrangement brings to the bureau the most able of the men in the rank and file of the department, and gives them such training that their efficiency as officers, after their term of duty with the bureau, is increased. This phase of the activity of the bureau,—the maintenance of what amounts to a training school for the future officers of the department,—is not by any means a negligible feature of its work.

During 1914 the bureau made 119,515 inspections, and corrected violation of the fire prevention ordinance in 33,190 premises. The improvements ordered related to such various subjects as the storage of moving picture films, the installation of lighting systems, the removal of rubbish, the institution of fire drills, the installation of automatic sprinkler systems and the storage and handling of explosives. At the same time the bureau examined all plans for new buildings to be erected in the city, except those intended for dwellings. It also passed upon almost innumerable plans for the setting of furnaces and other heat-using appliances. Through the city prosecuting attorney it brought suits in 712 cases of violation of ordinances and in 573 cases found it advisable later to take non-suits because the violations had been corrected before the cases came to trial. This is significant of the efficiency of the bureau's methods, which look first to the improvement of unsatisfactory conditions rather than to the punishment of the offenders.

It has been found that buildings occupied for certain purposes in many cases had unsatisfactory conditions peculiar to their class, and it was found desirable to prepare circular letters relating to some such classes, addressed to owners, agents or occupants of the buildings. A typical letter of this sort was that delivered to each church in the city calling attention to the provisions of the ordinances relating to keeping aisles and exits unobstructed, to mounting exit doors so that they will swing outward, to keeping exit doors unlocked during services, to

providing fire extinguishing apparatus and to maintaining suitable lighting systems. Circular letters were sent to contracting plumbers, citing the prohibition of the use of gasolene torches for thawing frozen water pipes. Letters of this kind have brought favorable results.

At the request of the Wholesale Clothiers' Association fire drills were organized and safety appliances recommended in 150 factories making garments of various kinds. A fire has occurred in one of these factories, and it was extinguished without important loss by the private fire brigade attached to the factory; in the opinion of the owner this favorable result being due to the fact that the recommendations of the bureau had been adopted. Fire drills have been instituted in many buildings, especially in the large department stores. From the beginning, particular attention has been given to automobile garages, dry-cleaning establishments and other classes of occupancy involving the use of large quantities of volatile and highly inflammable liquids. A large proportion of the dry-cleaning establishments in the city was found to be violating the ordinances, and most valuable work has been done in reducing hazards in such buildings. During the past two years 188 dry-cleaning plants were caused to remove hazards which constituted infractions of law.

Before the organization of the bureau it was the practice of the fire department to require that battalion and company officers make regular inspections of buildings within their territory, mainly to become familiar with conditions that would affect the work of the department in fighting fires, and rather incidentally to observe and report upon hazardous conditions which should be improved. Since the establishment of the bureau with a specific ordinance prescribing proper methods of fire prevention, and an executive organization for dealing with violations, the inspection reports of the fire department officers are sent to the bureau, and the results obtained have been much better than in former years. Thus the beneficial effects of the new organization are not confined to the particular premises inspected by its own men.

It is to be expected that the good work done during the rather short history of the bureau is significant of even better

things to come, as the organization increases in size and as the educational work carried on by it and other organizations becomes increasingly effective in influencing the public consciousness toward greater attention to fire hazards and greater intelligence in their treatment. There is no doubt that such educational effects are already apparent. To cite one example, a cry of alarm in a Chicago theatre does not now cause a panic and resulting loss of life. In more than one instance, large assemblies have been startled by the cry of "Fire," and have dispersed in an orderly manner through the adequate passageways and exits now provided in compliance with the law.

The work of the Bureau of Fire Prevention and Public Safety is not spectacular. A fireman detailed as an inspector finds that ashes are kept in a wooden barrel. He reports the unsafe condition and in due course a metal receptacle is provided. His brother member of the department drives a mammoth motor truck through crowded streets and brings brave rescuers to the aid of the unfortunates trapped in a burning building. Both men do their duty. It may be that the first has accomplished even more than he who plays the more conspicuous part. As this article is written, news comes of a fire in a school at Peabody, Massachusetts. The bodies of twenty little girls, burned beyond recognition, have been taken from the burned building. How many more are still in the ruins no one knows as yet. Marvels of bravery are reported. The devoted teachers risked their own lives. The firemen, the police, the residents of the neighborhood, did all that could be done to save the hundreds in the school. Most of them were saved, but the horrible death of those who could not escape, the agony of spirit of that community today, come home with crushing emphasis to any one who reads the story. And yet we may forget. We have had our week's wonder at the Slocum, the Iroquois, at Collinwood, at Boyerstown, at Houghton, at the Triangle fire. We wonder that such things can be,—and go about our daily work, until a Peabody disaster reminds us that the conditions that have taken lives in the past still exist. They are being reduced in number, little by little, by such organizations as our new Chicago bureau, working quietly, with little or no newspaper publicity, removing scores of potential causes of fire every

day, installing means for saving life if fire comes, and making the most of every opportunity to teach the public that fires are in most cases preventable, and that the preventive measures are not especially difficult. That intangible thing called public sentiment is sometimes difficult to arouse. We have seen that it can be influenced for good, and that in some respects Chicago has learned from experience. Much remains to be done. It is encouraging to know that there is in the Chicago Bureau of Fire Prevention and Public Safety an efficient agent for doing it.

THE ENGINEER AWAKES

Abstract of an address before the American Association of Engineers, September 14, 1915.

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Now is the day of awakening of the engineer as a man and as a citizen to a larger realization of his duty to society in general, to his profession, and to himself in particular. He is not alone in this. The world-wide war has shocked into life many dormant conceptions and has opened the eyes of mankind to the larger claims of brotherhood. The horrors of the destruction of life and property and the ruthlessness with which the accumulations of centuries and the hopes of the future have been sacrificed is bringing about a reaction and is preparing the way for the growth of a larger human consciousness. The engineers in this peaceful country are not unaffected. Their occupation in a large part has been reduced and as a result they have been afforded time and need for thinking on these vital matters. They are getting fully awake to their part in the world's progress.

There is nothing really new in this awakening, except perhaps in the greater intensity and vigor of the accumulated forces at work. Life with its rythmic character is a constant series of awakenings; we remain quiescent or sleep until hunger sharpens the appetite and forces a clearer realization of surrounding conditions. This is literally true at the present time. The hunger or threatened hunger of large numbers of professional men is causing them to note more keenly their surroundings and their relations to each other and to the public.

More than this the present century is that of organization. The zeal for the study of efficiency, the demand for larger and more effective organizations, the value of preparedness, all of these are being forced on the attention of the thinking man; he is seeing as never before the need of organization and of sacrificing of some of his individuality in the interest of work for and with his neighbor.

What distinguishes an engineer? Before going further into details of this awakening, it may be wise to inquire what we mean when we speak of the engineer. It is a word in common use, but few of us can agree upon a definition. We ride on the railroad train; everyone knows whom we mean when we speak about the engineer of the train, and yet in the present talk we do not consider this man as necessarily belonging to the engineering profession. Our lives depend largely upon his faithfulness to duty, his intelligence and his skill; no man ranks higher in public confidence than the locomotive engineers who are safely carrying each day millions of passengers. In our present discussion, however, we have in mind not the engineer who operates an engine, nor the mechanic however skilled he may be, but rather the man, who may be a mechanic or engine-runner, but who is essentially something more. What is that quality which we are endeavoring to include in the term engineer as generally used?

The quality which distinguishes the engineer as a professional man from his brother the mechanic is education. The engineers is undoubtedly benefitted if at the same time he is a good mechanic, although he may be a success even if he has little or no mechanical ability. To be an engineer in the true sense, he must have, however, that education which enables him to understand the true perspective of things, to know the big from the little, to obtain facts and judge correctly from these.

Why should he serve? The education of the engineer whether obtained through books or through things has been largely at the expense of some other person—either society, the state or his more immediate employers. If he is a graduate of a university or an engineering school, the cost of his education, in part at least, has been borne by the philanthropically endowed college or by taxes levied directly or indirectly for the support of a state institution. If he is not a college graduate his early education has been more largely at the expense of his parents and to a less degree at that of his employer. It is assumed usually that in the case of an employer he has returned value received, but most of the older engineers will testify that they have usually made large investments in educating young and untrained men from whom they have not always received a full return.

However this may be, it is safe to say that the majority of engineers are indebted to some one for the opportunities which they enjoy; as a body they owe a duty to the state and to society as well as to their profession.

ETHICS. It is this recognition of duty which gives rise to the ethics of the engineering profession and which distinguishes the engineer as a professional man from the ordinary mechanic, who from lack of this education does not feel bound to the same degree by written or unwritten codes. These ethics are well recognized, although, like many other matters of common knowledge, they are often difficult of exact definition. We know when they have been violated and yet may debate long as to the exact line between ethical and unethical conduct. The conception of engineering ethics is fundamental to the profession, and finds its highest expression in *service.*

Service to the public and to the engineering profession by means of service to the members should be the motto of any organization of engineers.

SERVICE. What is this service which all should be eager to render and which is the fruition of years of training? What do we mean when we claim that the highest function of the engineer and his greatest reward is found in effective service? The word conveys the idea of help rendered to another, not as a favor involving an obligation, nor on the other hand as a matter of self-sacrifice. It is something which may be expected though it can not be demanded, and may be performed among equals. Service consists of those acts which tend to lessen trouble or increase the health, prosperity and convenience of others.

Engineers in performing service are by this very fact entitled to full recognition. Service implies—a suitable reward and while the effort may be altruistic, it does not involve unnecessary self-denial. A proper remuneration, one assuring a good living, is due to the engineer. He who performs service rightfully does it with full expectation of reward, directly or indirectly in the satisaction of duty well done.

In every age and climate men have felt the impulse to be of service to their fellow men. This has been manifested in innumerable ways, ranging from an intense religious enthusiasm,

shown by a desire to convert all men to their way of thinking, or to the perfection of codes of laws designed to elevate mankind. The attempt during the early ages was to reach the ultimate by some short path; to convert the heathen by a rigorous campaign at once. In later years, however, we have come to recognize that the improvement of the human race as a whole must necessarily be slow; we are more content to take shorter steps, with consequent surer progress. Thus, the altruistic motives of the present generation are characterized by intense practicability. Much of the energy which in olden times might have been devoted to the task of saving men's souls is now expended in saving their digestion; in so doing the ultimate saving of their souls may be made easier.

One of the more recent manifestations of this altruistic spirit has been in the so-called conservation movement,—initiated largely by engineers—essentially an appeal to patriotism, characterized by love of mankind and having a deep religious significance. Other manifestations are in the rapidly increasing number of movements for civic betterment, for better farming, better schools and better homes made possible by the study of domestic economy. All of these are manifestations of the desire to be of service, to promote the public welfare, to lift man out of ignorance and poverty to a point where with the enjoyment of larger physical comforts he will be better prepared to more fully utilize his better qualities.

ENGINEERING SERVICE. Among all the various occupations there is none which is more capable of leading in service to mankind and in realizing higher ideals than the engineering. The engineer should be a man of vision—a missionary of light and progress. His life is devoted to careful, impartial measurement and weighing of facts. He can not afford to be deceived or to mislead others on these facts; having ascertained them in their true proportion, it is then his business to idealize, to plan and to use his ingenuity in devising methods for adding to the comfort and convenience of mankind, such for example, as through better conditions of transportation, of communication, of heating, lighting, water supply and of the things which tend to produce better health and longer life in the community.

HAMPERED BY IGNORANCE. In this work, the engineer is far ahead of the public. The latter in many ways has not yet caught up with the growth of knowledge and does not appreciate the possibilities which are awaiting realization under the magic touch of the skilled engineer. The people as a whole do not as yet have the vision of better things which lie within their grasp, and which can be called into being when ignorance is dispelled. Many a community is existing or even declining because it does not utilize the available water supply or have constructed the needed sewerage system. The more progressive people and the young men are leaving to go to localities where these better things are accomplished.

The public is not wholly to blame. The engineer in part is to a certain extent culpable. He has not fully felt the need of diffusion of information, except among his professional brothers. He has not taken the public into his confidence and explained in simple terms, in ways that would attract the public, the results already achieved, nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work effects him or how his condition may be improved. The farmer continues during his lifetime to drive up and down the hills, wasting time and effort because the engineer has never brought home to him that it is practicable at moderate cost to improve the grades as well as the surface of the roads.

NUMBER OF ENGINEERS. Without attempting to discriminate very nicely between the different classes of men who may be considered as engineers, it is safe to assume that there are in North America over 100,000 men whom we would class as "engineers" outside of the purely mechanical occupations. Of these over 40,000 are members of approximately 100 organizations. The greater part of this number is included in four great national societies, the membership of which in round numbers is as follows:—

American Society of Civil Engineers..........	7,700
American Society of Mechanical Engineers....	6,100
American Institute of Mining Engineers.......	5,000
American Institute of Electrical Engineers....	7,750
	26,550

The above total of 26,550 includes many duplications, particularly of names of the more prominent engineers, as they are usually members of two or more of these larger national societies. It is safe to assume that there are at least 20,000 engineers, embracing most of the men who have become leaders in the profession, included in the membership above noted.

These organizations have their headquarters in New York City, three of them in the Engineering Societies Building (29 West 39th St.), the headquarters also of a number of small organizations. Many efforts have been made toward coöperation among these and at one time it was hoped that all four societies would come together under one roof. It is still possible that such results may be accomplished. There are certain advantages to be derived from physical contact, even though there may be no organic connection. Progress has been made to some extent at least by the formation of a Society of Technical Association Secretaries by which means a certain unity of action may be produced on matters of common interest.

The organizations next in point of size are the Engineers' Society of Western Pennsylvania with headquarters at Pittsburgh, 1,150 members, and the Western Society of Engineers with office in Chicago, 1,200 members; next the Associated Engineering Society of St. Louis with 800.

The hundred or more local engineering societies organized at the principal centers of population have a membership each of from 100 or less up to 500 or more, averaging about 200. The importance of these societies has not been fully appreciated, even by their members, and the most enthusiastic will hardly claim that they are as yet fulfilling their largest or best function. They have in one sense boundless opportunities for useful work if only they can grasp them.

The total membership of these local societies aggregates in round numbers 20,000 so that for the purpose of discussion we may say that of the 100,000 men who claim the right to be called engineers, 20,000 are members of the four national societies with headquarters at New York; about an equal number, including many of the above, are members of local societies, leaving over 60,000 of the men not enrolled in any engineering organization.

In this great group are many men of ability and standing in the profession, but who have never seen the necessity of joining with their fellows in organized efforts. By far the greater part, however, are the younger or less prosperous men who are performing routine work in engineering offices or engaged in the details of the country surveyor and engineer. As a whole, they include the more poorly paid professional men whose compensation averages less probably than that of the high grade mechanics. We do not have any definite data on this point; but those who have employed engineers and graduates of engineering schools are aware of the fact that under present conditions at least, we can obtain the service of highly educated skilled engineers as computers, draftsmen, office or field assistants at a nominal wage.

It is not the "submerged tenth" but the six-tenths for whom special appeal should be made to ascertain whether their condition may not be improved by applying to it the same painstaking study to ascertain the true facts and to provide a remedy as should be done by the engineer to meet and overcome physical obstacles. If we can solve some of the great problems of control of electrical current, of storage of floods, of winning coal and iron from the earth, of devising ingenious mechanism, we should be able by using the same degree of intelligence to materially improve the human machinery. We have, however, in the past often overlooked the things which lie nearest to us while going to the unsettled west, or to the ends of the earth, to attempt tasks more remote.

STILL MORE ENGINEERS. To his large body of engineers there is being added each year about 5,000 recruits, mainly from the engineering colleges, more or less well trained in the fundamentals of engineering. There was a time within recent years when there was demand for every one of these young men in active engineering work. At present, however, it is necessary that many of them go into other lines. It is not to be supposed that their education is by any means wasted, as the training of a good engineering college is probably the most valuable to be had, in preparing young men for their life work in lines of trade and commerce. While during the first few years they may not receive salaries as high as that of other men

of their age who have gone into business directly from the common schools, yet in the long run the training they have acquired gives them opportunities for more rapid substantial progress.

One of the problems that is now confronting us is the fact that each year this large group of graduates, as well as the thousands of young men employed in engineering offices, is coming into a profession apparently overcrowded. This overcrowding, however, is more apparent than real. A relief is to be obtained not by limiting the influx of men, but rather by widening the field of service.

OPPORTUNITY. The field is practically unlimited, the bounds extending with every improvement in the conditions favorable to human health, comfort and industry. Artificial limits, the cramping efforts of which we now appreciate, are set solely by ignorance. They exist only in the mind, and arise because of lack of knowledge by the public in general and of individuals in particular. To put it in another way, if every taxpayer and voter in the country, every town, city, county and state officer was fully aware of the conditions which surround him, and the extent to which the engineer could remedy or improve these conditions, there would be an immediate demand for all engineers who could be found. Take for example, the matter of road building. The public has been slowly educated toward the needs of good roads, but not so fully to the fact that to build these good roads a certain amount of skill and experience is needed. We have the spectacle, surprising in a country which prides itself on its good sense, of millions of dollars being spent on new roads and in improving old roads, often without any preliminary survey or study of correct location or preparation of plans and estimates, nor of adequate supervision of the work, even if well planned.

The amount of money which is being wasted today in the amateur efforts of elected officers, who will be replaced next year by men no better qualified, would furnish employment to a great part of the engineers in the country. The point to be observed, however, is not that we are arguing for the employment of these men, but that the claim is based upon the far more substantial grounds of benefit to the public and to the man who pays the bill.

Take the matter also of public health. Imagine for a moment that every local official was aware of the conditions which are affecting the health of his community and of his family, and that he knew that these conditions could be remedied by intelligent and skillful engineers, and moreover that the cost of this work would be far less than the extravagant waste of time and money now taking place because of preventable sickness and death; would he not at once set about employing the man who could save not merely the money values, but what is far more precious, the happiness and lives of his own kind.

The opportunities are boundless—they stand on every hand ready for us when we awake. Listen! opportunity speaks!

> "They do me wrong who say I come no more
> When once I knock and fail to find you in,
> For every day I stand outside your door,
> And bid you wake, and rise and fight and win!"

SALESMANSHIP. To properly seize the opportunity the engineer who rises to the occasion must cultivate some of the qualities summed up in the term *"salesmanship."* We recognize that the success of many a merchant is due to a peculiar art which he has acquired and one which enables him to sell goods at a profit. We have more slowly come to recognize the fact that his success is due not to the fact that he personally makes a profit, but that the other party, the world to whom he sells, is benefitted. It is true that for a time the merchant may sell inferior goods and may temporarily make money by so doing, but in the long run he has learned that the established business can only rest secure on honest advertising and on the realization by the public that he is performing a real service to mankind.

In the same way, the engineer to succeed must acquire the art of salesmanship. He may not recognize or label the quality and may even deny its existence. He points to the code of ethics rigidly observed against advertising or self-exploitation, and yet while conscientiously observing all proper rules of ethics, he may possess to a high degree the real art of presenting his ware in such a way as to convince the world that the general welfare is promoted by purchasing from him.

He has for sale not boots and shoes or legal opinions, but what is more difficult of delivery, he has ingenius but true ideals, he has imagination, trained by years of study and practice. He has acquired the power of making these "dreams come true," in proportion that the public or his employer recognizes these qualities, to that degree is he able to sell his wares. There is perhaps nothing more instructive to the young engineer than to try to ascertain the methods of salesmanship which has led to the recognition of certain well known and respected engineers. Some have succeeded through or in spite of extreme modesty and a reticence which has been hard to break through; but in each case there has been not only true value of the goods to be delivered, but some quality of mind or action which has impressed upon others the fact that the goods are of superior value.

PARALLEL LINE OF ACTIVITY. In the preceding pages there have been very sketchily outlined, the opportunities for service and an indication given of the great body of men who are available for such service to the community—one for which they are entitled to proper reward. In what has been said, it is apparent that there are difficulties to be met. In the present awakening innumerable schemes have been suggested for action but most of these fall under one or another of two principal lines.

First, co-ordination and co-operation of existing engineering societies and organizations.

Second, formation of one or more new associations devoted almost exclusively to the material welfare of the engineers.

These movements are the natural outgrowth of the discussion and unrest which has prevailed. They are not antagonistic and may be mutually helpful. Not all men think alike and the path which will be attractive to one group is not to another.

In establishing a new movement or society the burden of proof of the need of such organization is upon the promoters. If it is proposed to assume new costs and create new obligations, it must be clearly shown that there exists not only real need for this additional machinery, but that the public will be the gainer thereby. It is hardly to be expected under present conditions that any plans will be cordially received by the officials and by

supporters of long established and tested societies. As a rule engineers are conservative. They prefer to trust to veterans in the cause rather than to new volunteers and above all things look for the efficiency and economy which comes from unity of action.

We can therefore hardly present too strongly the arguments for branching out on any new line. In what has been said, it may appear as though undue emphasis has been placed upon the public welfare and too little upon the benefit to the individual. It goes without saying that the individual must be convinced that he has much to gain in entering upon a new movement, but at the same time we must not lose sight of the fact that no such movement as is now discussed can be successful unless it is firmly founded on the public welfare. This may sound a strange doctrine to those who have not given thought to the matter; it is the popular conception that every business man is looking out for himself and that his success is based upon purely selfish considerations and that every organization must do likewise.

If we go deeply, we find that in a free country no volunteer organization can long exist which is founded on purely selfish motives. The public does not long deal with the merchant who does not give fair bargains and it does not look with favor upon any body of men brought together for confessedly selfish ends. If, therefore, any movement should be so unfortunate as to start with the handicap of popular misconception that it is devoted solely to the financial gain of its members, the future history would likely be short and stormy. For this reason the benefits kept prominently in view should be those, not of individuals, but of society as a whole.

Summing up the needs and opportunities, it appears that a great part of the main body of engineers is not fully employed to the best advantage to society and to themselves with corresponding loss to all. Nearly two-thirds of those who may properly call themselves engineers, or perhaps 60,000 men, are not members of any well-recognized organization, and are not utilizing their potential strength to help themselves or each other. There is need of enlightenment, of raising ideals and of united effort toward better things. The existing engineering organizations, which include perhaps 40,000 men are devoted almost ex-

clusively to technical questions as distinct from those things which concern the engineer as an individual and a citizen. Few of the older societies attempt to bring in the rank and file of the profession, or attempt to cover the field of the new American Association of Engineers, in its efforts to help and reach the masses of the profession.

PRESENT PROGRAM. The program already laid out by the American Association of Engineers is so inclusive that it is hardly possible to briefly comment upon it. It is founded on the solid basis of proposing primarily to raise the standard of ethics of the engineering profession and to protect the economical and social affairs of engineers.

Ethics, as already defined, result in effective service, and in the recognition of the duty which every engineer owes to his fellow men. Any code of ethics is merely a re-statement of "the golden rule" to do unto others as you would have them do unto you.

The promotion of the economical and social welfare of engineers involves a broad program as wide almost as that growing out of the practical application of a standard of ethics or living up to the golden rule. Their welfare is tied up with that of the society in which they live and begins with aid to that society accompanied by recognition on the part of society in general of the proper reward for services performed.

FIVE CHANNELS. It is proposed to carry out the broad program above outlined through five specific channels.

A. The first of these is by affording means for the interchange of information; this being vital to all of the functions.

B. The second channel is that of maintaining a service clearing house. There is probably no one matter in which the engineers as a whole are so deficient as in those things which pertain to employment. The engineering colleges are graduating hundreds of young men into a profession apparently overcrowded. Each employer is besieged with applications. There has probably never been a time when so many competent engineers were out of work. There are innumerable employment agencies and some of the larger engineering societies have undertaken in more or less mechanical way the diffusion of information concerning employment. There is, however, no sys-

tematic treatment of the subject such as is creditable to a body of men of the high intelligence of engineers.

It should be possible for the engineers of the country to study the vital question of employment and to devise a system which will obviate much of the wasted time and effort. Every day lost by a man hunting a job is not merely a loss to him, but is a greater loss to the community. This loss consists not merely of his wages, but more than this of the valuable results which flow from his employment. There is thus no one question presented to the engineers as a whole which is more important to the individuals and to the society at large than this of attempting to solve the employment problem.

C. The third line for raising the ethics and the welfare of engineers is within a relatively new field, that having to do with patents. It is really one of the branches of law in which the engineer has been conspicuously weak. It might well be expanded tc cover other similar legal relations with the public.

D. The fourth item is one of peculiar delicacy and one whose importance is only equalled by the dangers involved. The moment that any body of citizens organize not as citizens, but as a distinct class of professional men and begin to enter upon the domain of law making, they become an object of suspicion. This should not be so, but nevertheless we can not shut our eyes to the fact that every one of us has a feeling of uneasiness as to the political activity of doctors, lawyers or ministers working as such avowedly for their own benefit as professional men. There is no doubt but what there has been great neglect of duty in the line of education or of diffusion of information to the members of the law-making bodies. As citizens, all engineers have a duty to perform, but when organized too great care cannot be taken to have it clearly understood that engineers acting together are concerned not immediately for their own personal benefit as a class, but are performing a service for the public.

E. The fifth line, that of proper publicity, is really the all-inclusive activity in that it involves and brings about most of the aims before noted. Publicity means turning in the sunlight, dispelling the darkness of ignorance and driving away the shades of half truth. The full and proper diffusion of information results in a wide increase of work, brings about liberal employ-

ment, aids in serving as a guide to the engineer in all his work for the public while at the same time giving the public a proper appreciation of the work performed.

CONFIDENCE. For success in these movements there must be not only a high purpose with energy, enthusiasm and devotion on the part of all concerned, but more than this all actions taken must be such as to maintain full confidence on the part of the public in the purity of the motives inspiring the men who are leading. There is nothing which so quickly destroys as a suspicion that self-interest is at the bottom. No movement has been of permanent value which is not founded on intelligent altruism. It is true that occasionally men have organized and succeeded for a time by a more or less indirect use of force, but such success is temporary, unless it has joined with it a recognition by the public that a broad benefit is being conferred upon all.

Confidence is inspired by full publicity, by avoiding any appearance of secrecy and by keeping all action open to the full light of day.

THE FUTURE. Assuming that the great mass of engineers are now awakening to a full appreciation of their opportunities there is every reason to suppose that with the use of their united intelligence an early and sure progress can be made. We can not at once overcome all of the inertia of the past, but with a wider diffusion of information, we may confidently look forward to a rapidly widening field of work and a larger appreciation of results to be attained. If we could only comprehend the power for good that exists in the united effort of this great body of intelligent, experienced men, we could see that nothing can withstand their efforts. Properly directed, they may bring about in the near future even greater progress than in the past in the promotion of general welfare by the development of new industries, the creation of new means of communication, as well as the improvement of those now existing to a point where the dreams of the most optimistic have become solid facts.

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THE NECESSITY FOR STUDYING SPANISH IN AMERICAN SCHOOLS OF VARIOUS KINDS AND GRADES

POSTULATES

First. No one can appreciate fully the niceties of his mother tongue and obtain a thorough command of it who has not had to struggle with the grammar of some foreign language.

Second. According to the established dicta of the solons, extending back for several centuries, no man can be considered truly educated who has not studied other language than his own.

Third. The idea prevalent in America that it is impracticable to teach students at all thoroughly any modern foreign language

without their sojourning for a while in some country where that language is spoken exclusively has been proved, beyond the peradventure of a doubt, to be erroneous.

Fourth. The study of Latin and Greek has no practical value whatsoever, excepting only that of the mental training which the said study affords.

Fifth. A knowledge of the French language is a gentlemanly accomplishment, which no one for any consideration would part with after he has once attained it; but it is very seldom of any commercial or financial value to an American.

Sixth. While a knowledge of German is helpful in certain scientific lines to a few well educated Americans, for instance, in those of chemistry, and hydraulics, its universal study in the United States would prove of no great value to the masses of the people nor to the country as a whole.

Seventh. The plea that technical men need to be able to read French and German in order to keep themselves posted concerning the latest scientific developments is a fallacy, because anything of real value that appears in foreign literature is very quickly translated into English and published either in American periodicals or in book form; moreover, there are more good books and papers printed in English these days in all lines of technical work than the practitioners can possibly find time to read.

Eighth. The American nation in its make-up is essentially utilitarian, and is prone to seize eagerly every opportunity offered for obtaining anything of great value, especially if it can be secured without much effort or expense—for example, the utilization of by-products in all lines of manufacture.

Ninth. One of the most promising fields for American enterprise in all lines of business, and especially in technics, is the Latin-American countries; for they are now in the same process of rapid development as the United States some thirty or forty years ago.

Tenth. The reason why American business men and engineers have not exploited this wide field is that up to the present time they have had about all they could do at home to attend to the development of their own country; but today conditions have changed, and Americans now need a larger scope for their activities.

Eleventh. Those few progressive Americans who in times past have attempted to enter the South American and Central American fields have experienced great difficulty and have been seriously handicapped because of European competition. As the English and the Germans have made a practice of lending money to most of the Latin-American countries for the materialization of important projects, they have insisted that to their own countrymen must do all the engineering, all the contracts for construction, and the furnishing of all supplies connected therewith—in fact, not infrequently also the future management of the completed enterprise. This has made it almost impossible for American business men to supply anything of American manufacture to those countries, except a few articles that were so manifestly superior to those of European make, or so much less expensive, that even the European contractors could not avoid buying them.

Twelfth. Owing to the existing war, there is no European capital available for lending to the Latin-American countries, nor is it likely that there will be any for several years to come—the longer the war lasts the more exhausted financially will the various nations become, and the longer will be the duration of their inability to finance projects outside of their own countries. Again, the entire mercantile fleet of Germany has been either destroyed or interned, hence that country in particular is now out of the reckoning as regards business competition. On these accounts this is certainly the great opportunity of the United States to secure permanently the Latin-American trade.

Thirteenth. American manufacturers do not thoroughly understand the needs of the Latin-American peoples, who naturally desire to purchase articles specially suited to the various requirements of their countries. One of the principal reasons for this lack of knowledge is that the officers of the said manufacturing companies, not being able either to read or to speak the Spanish language, cannot learn what such requirements are.

Fourteenth. No business agent can successfully carry on negotiations in a foreign country, unless he is able to read, write and speak the language of that country.

Now what are the deductions to be drawn from this group of premises? Evidently there is one of prime importance, viz., that

it is incumbent upon Americans to learn thoroughly the Spanish language, and that it should be taught not only in all the technical schools of this country, but also in most of its other institutions of learning, including the universities, the colleges, and the high schools—and possibly later on even the schools of lower grade.

It should be substituted for Latin and Greek as a mind-trainer wherever those dead languages are made obligatory studies; and it should replace French and German where these are given as regular courses, leaving all other foreign languages, both dead and living, to be taken as optional work. Let no one fear that Spanish is inferior as a mind-trainer to either Latin or Greek, for such is not the case. It is true that Spanish literature is not quite as valuable as French or German, especially in technical lines; but that is a matter of slight importance, because, as previously indicated, American literature (when properly supplemented by translations) is all-sufficient for American needs.

There is a crying necessity today in our country for a small army of young men and women who can read, write and speak Spanish fluently and well, in order to capture the Latin-American business that is going a-begging. Such an army certainly would require time for its training, but far less of it than most people imagine; because a truly expert teacher of Spanish, giving lessons to night classes three times a week, can so train young people of ordinary intelligence (provided that they are really in earnest and are gifted with the requisite amount of energy and enthusiasm) that in less than a year they will obtain a fair command of that tongue, and with two years' instruction they will become truly proficient therein, being then able to understand it instantly and without mental translation when it is properly spoken, to read all of its ordinary literature readily and without the aid of a dictionary, and to express themselves therein freely, forcibly and without hesitation.

To accomplish this, though, requires excellent instructors, and these should invariably come from countries where Spanish is spoken; because, with very few exceptions, no one can teach really well any language except his mother tongue. Those who in early youth were fortunate enough to be bi-lingual, of

course, are the exceptions to this rule, as may be also a certain few individuals who have the gift of learning to speak foreign languages easily. Unfortunately, however, such persons are not always good teachers, and the knowledge they acquire is liable to be superficial. To be really successful any teacher must be both energetic and enthusiastic—in fact he should also be magnetic and masterful, so as to encourage and even to force his students to put forth their best efforts.

After the first week or two in any Spanish class, all teaching should be done entirely in Spanish, and the pupils should not be permitted to employ a single English word in the classroom. Sometimes a penalty of a cent a word may be found to be necessary in order to establish such a practice, the proceeds of the fines going towards some social function for the class, in which function, of course, the speaking of Spanish should be a *sine qua non.*

To accomplish what is needed, there would be required throughout the United States a large body of Spanish teachers who are expert language instructors. Such men and women are not easily found, and their services would have to be adequately remunerated. Undoubtedly they could be secured from the various Spanish speaking countries by proper and careful selection. Preferably, they should have a fair knowledge of English; but this is not absolutely essential at first, for they would soon pick up enough of it in the United States to enable them to carry on their classwork.

It would be a good move to form at Washington a board of examination for Spanish teachers by retaining for the purpose half a dozen of the very best of them that are to be found in this country. These men not only could serve as examiners, but also could give general advice about how best to teach their language, and could negotiate with those of their countrymen whom they know, either personally or upon good authority, to be fine teachers, and induce them to come to the United States to practice their calling.

Something radical should be done, *and done now,* to effect the *desiderata* herein suggested; for otherwise our country will run great risk of losing the unique opportunity for dominating the foreign business of Latin-America which the peculiar present

world-conditions now offer. The best possible organization to attend to this work is, of course, the United States Government; but failing that, there ought to be found groups of patriotic men of means, influence and ability to undertake the task.

J. A. L. WADDELL,
Consulting Engineer.

THE IMPORTANCE OF CITY PLANNING

BY CHARLES H. WACKER
Chairman Chicago Plan Commission.

City planning is the most important public problem confronting large cities today. This is true because the proper direction of the growth of a municipality in an orderly, systematic way is really fundamental and underlies all social and commercial problems. Commercially it has to do with the systematic arrangement of streets and avenues within a city in order to save time and effort in the movement of people and merchandise between the various sections, and the perfection of all kinds of transportation. Socially it has to do with adequate provisions for the public health through the most advantageous location of recreation facilities, the provision of quick and easy access thereto, and the opening to light and air of congested housing districts. The basic relationship of city planning to these various other public problems is well indicated in connection with the housing question, because before an adequate solution of the housing problem can be had proper street facilities are requisite in order to permit access to and from the home and the place of work. Social endeavor is more and more emphasizing the need for adequate recreation facilities because it is universally recognized that city life is more intense and nerve-straining than life in the country. A proper city plan forms the foundation upon which comprehensive recreation facilities may be provided at the most essential locations. Next to convenience and orderliness in its street arrangements, the most requisite thing in a great city is a sufficient park area. Parks of a city have been aptly compared with the lungs of a person, as means by which the city and

its people get the stimulus of fresh air so necessary to normal well being.

The vital importance of city planning is best comprehended when it is realized that a world-wide movement of people toward cities is in progress. More than half the people of the United States now live in cities, and one-tenth of them live in three cities alone—New York, Chicago and Philadelphia. Cities everywhere are growing at an astonishing rate, and such growth is forcing the solution of many new problems. Such problems include those of developing the city in an orderly and economic way; of curing and avoiding street congestion; of providing light and air in the streets and in the homes; of having more and larger parks; and of creating more attractive surroundings for the people as the city extends its borders. Unless those problems are rightly solved, municipalities cannot continue to grow and the people continue to be healthy, happy and prosperous. Thus it can be seen how important city planning really is as the foundation for all civic advance.

As the only means to avoid disaster due to haphazard growth, Chicago has entered upon a big constructive task of carrying out the Plan of Chicago. This general plan, with its two hundred miles of street improvements, its parks and playground sites, and its magnificent development of the shore of Lake Michigan, is fundamentally hygienic and humanitarian. It is designed to solve three problems of grave importance—the relief of congestion, which means the crowding of large numbers of people into small areas; the facilitation of traffic, which means the movement of merchandise and people from one part of the city to another; and the safeguarding of the public health by giving the city more and larger parks and playgrounds and better and wider streets, and thus make the entire citizenship more healthy and better able to carry on the work of commerce and civilization.

In brief it may be said that the general Plan of Chicago provides for adequate circulation of traffic, by widening and extending existing streets; but cutting new ones; and by connecting all thoroughfares in a systematic and orderly way; for the creation and development of parks in each section and within the city limits; for the reclamation and improvement of the banks

of the Chicago River; the creation of the great outer lake front park, watercourse, and shore boulevard to extend five miles in length from Grant Park in the center of the city south to Jackson Park; for the construction of two magnificent recreation piers extending far out into the lake; for the development of a yacht harbor opposite Grant Park; for the creation of five large forest preserves lying close to the city's borders on all sides of the city; for the creation of a complete system of good roads encircling and radiating from the city; for adequate transportation facilities; including the proper location of freight and passenger terminals, and for the location of national, state, county and municipal buildings in correlation.

The pioneer city planning work undertaken by the Chicago Plan Commission was the creation of a quadrangle, or traffic clearing base, encircling the heart of the city, composed of Twelfth Street on the south, Canal Street on the west, Michigan Avenue on the east, and Chicago Avenue on the north, Twelfth Street is to be widened from 66 to 108 feet for more than a mile between Ashland Avenue and Canal Street, and to 118 feet for a mile from Canal Street to Michigan Avenue. The improvement of this thoroughfare is now practically assured. The court proceedings in the condemnation case began on June 29, 1915; the bond issue of $1,750,000 for "public benefit" has been voted by the people; the $521,000 new Twelfth Street bridge has been provided for, as well as a $1,000,000 viaduct between Canal Street and Wabash Avenue; and the balance of the total cost of $4,500,000 will be paid by special assessments upon the property benefitted.

The eastern boundary of the quadrangle, Michigan Avenue is to be widened for a mile from Randolph Street to Chicago Avenue. It is to be made 130 feet wide south of the Chicago River and 141 feet wide north of the river. In order to segregate north and south traffic and separate it from east and west traffic, for several blocks near the river there will be two levels to the new street. The upper level will be used for light traffic, all buildings having their entrances and shop windows on this level. The lower, or present level, will be used for heavy traffic purposes, thus permitting the utilization of the basements of adjacent buildings for receiving and shipping purposes. All north

and south light traffic will use the upper level, uninterrupted by cross traffic. The importance of this segregation is readily comprehended when it is realized that sixty thousand vehicles every twelve hours of every working day traverse and cross Michigan Avenue in the zone of improvement. The total cost of the improvement is to be in the neighborhood of $8,000,000, of which amount the magnificent double-deck bascule bridge across the river is to cost $1,000,000. The people have voted a bond issue of $3,800,000 for "public benefit," and special assessments are to be levied upon benefitted property. The assessment roll in this case has been filed in court and the trial of the condemnation case will proceed in accordance with customary routine.

The northern boundary of the quadrangle, Chicago Avenue, is now wide enough The western boundary, Canal Street, is to be widened from 80 to 100 feet, and extended north to connect with Chicago Avenue, by means of a two-level bridge at Kinzie Street. This improvement is already under way; it is to be made at the expense of the railroads in connection with the west side terminal development, and by ordinance must be finished in four years time. In the settlement of the new west side terminal, the Chicago Plan Commission acted in its capacity as advisor to the City Council. In addition to substantial financial concessions, made to the city by the railroads, sixteen bridge, viaduct and street improvements provided for in the Plan of Chicago are to be made at the expense of the railroads.

The third major phase of the Plan of Chicago, and one slated for early accomplishsment. is the creation of 1,550 acres of parks along the shore of Lake Michigan from Grant Park in the center of the city south to Jackson Park. Upon the passage by the City Council of ordinances now being prepared, approving the park plan, and making proper harbor provision, it is confidently expected that the War Department at Washington will grant the necessary permit for the reclamation of Chicago's lake front for the people. Another improvement of widespread importance slated for early realization is the erection in Chicago of a new postoffice. November 1, 1915, at a meeting held in Chicago, the Chicago Plan Commission recommended to his honor, William G. McAdoo, Secretary of the Treasury, favorable consideration of the Commission's recommendation for the new postoffice

site of the two blocks on Canal Street between the present Northwestern and the new Union Station Company's terminals.

To remodel Chicago, the world's fourth city, is no light task. It is a Titan's job. But for its accomplishment Chicago has a citizenship which has never shrunk from herculean labors for the public weal. Chicago's people, awake and alive to their opportunities, are preparing for Chicago's destiny, and are marching forward shoulder to shoulder toward the benefits and prosperity that unquestionably will come to the city through the development of the Plan of Chicago.

In the May issue of the Armour Engineer Professor Phillips reported that of the contemplated buildings to be erected at Camp Armour, the civil engineering field school, the boat-house, the kitchen, and the wood-shed and ice-house were completed. This year's camp brings us the news that the administration building has been completed. The completed building together with views taken during erection are shown in another section of the book.

The Colorado State School of Mines presents its compliments to the Armour Institute of Technology and announces that the Board of Trustees have elected Mr. James Cole Roberts of the United States Bureau of Mines, Denver, to the Joseph Austin Holmes Professorship of Safety and Efficiency Engineering. Mr. Roberts will assume his duties November the first.

We were very glad to receive Bulletin No. 1 from the Kerr Auxiliary Company. Mr. C. V. Kerr, who was Professor of Mechanical Engineering during 1895 to 1902, is at the head of the Kerr Auxiliary Company which is engaged in the manufacture of the Improved Kerr Turbine with constant speed governor. The sales office is at 568 Peoples Gas Building.

Messrs. Kamansky and Bronewsky, Chief Engineers of the Obouchuff Steel Works, Petrograd, Russia, were recent visitors at the Institute. They were greatly interested in our laboratories and equipment.

The Society For The Promotion of Engineering Education have announced the appointment of the Committee on Conference of the American Association of Engineers. The members of the Committee are: Director J. F. Hayford, Northwestern Univ., Evanston, Ill., Dean W. F. M. Goss, Univ. of Illinois, Urbana, Ill., and Dean H. M. Raymond, Armour Institute of Technology.

Mr. Victor C. Alderson, formerly Dean of the Engineering studies, was a recent visitor at the Institute. Mr. Alderson is president of the Winnemucca Mountain and Bonanza Mining Companies. His address is 89 State Street, Boston, Mass.

We clip the following from the Technic, the publication of the Rose Polytechnic Institute:

"It is with pleasure that we publish Mr. H. B. Pulsifer's discussion of the metallurgical plants in and about Chicago. Mr. Pulsifer holds the position of Assistant Professor of Metallurgy at the Armour Institute of Technology. He is also an authority on matters pertaining to the practical side of mining and metallurgy, having done a great deal of expert work both in the Joplin zinc district and the Wisconsin copper fields. We congratulate ourselves upon being able to print an article by a man who is so thoroughly able to combine the practical and the theoretical."

Another definition might be given thus: "Modern engineering is a combination of science and art by which all strictly material productions that involve construction, either directly or indirectly, and which are serviceable to mankind, are evolved, designed and materialized." —*Waddell and Harrington.*

The Armour Bulletin

In these days of widely diversified engineering activities it is generally understood that those who are directing great engineering undertakings, manufacturing, municipal improvements, power plants, engineering of whatsoever sort, are men in close touch with the rapidly expanding field of scientific development. To emphasize the importance of our situation in a great engineering center we will endeavor to have The Armour Bulletin contain records and discussions of Chicago's most interesting engineering problems.—The Editors.

On the following page are illustrations of typical floor load tests made in the city of Chicago. These tests are made under the supervision of the Building Department, City of Chicago, on all re-inforced concrete construction and must show that the construction will sustain a load twice the sum of the live and dead loads for which it was designed, without any sign of failure. As required in the *City Building Ordinance* each test load shall cover two or more panels and shall remain in place at least twenty-four hours. The deflection under the full test load at the expiration of twenty-four hours shall not exceed one-eighth-hundredth of the span.

Fig. 1 shows the manner of testing an interior panel in the Gray Building. The span was 19 feet 9 inches by 19 feet 6 inches, and under the test load of 610 pounds per square foot the deflection was 12/32 inches. The building was designed by Architects Holabird and Roche, and the Alling Construction Co. were the contractors.

Fig. 2 shows the testing applied to a 18 feet 3 inches by 15 feet panel in the Blackstone Theater. The deflection was 1/18 inch under a test load of 300 pounds per square foot. Marshall and Fox were the architects and the construction work was carried on by the Roebling Construction Co.

* * *

Of the many important concrete jobs now in progress in Chicago the new Field Museum located on the lake front off Twelfth Street is especially interesting. The contractors are


USED IN THIS WORK
TURNER MUSHROOM SYSTEM
REINFORCED CONCRETE CONSTRUCTION
ALLING CONSTRUCTION CO.
GENERAL CONTRACTORS
GRAY BLDG MOSER PAPER CO.
HOLABIRD & ROCHE ARCHITECTS

Fig. 1

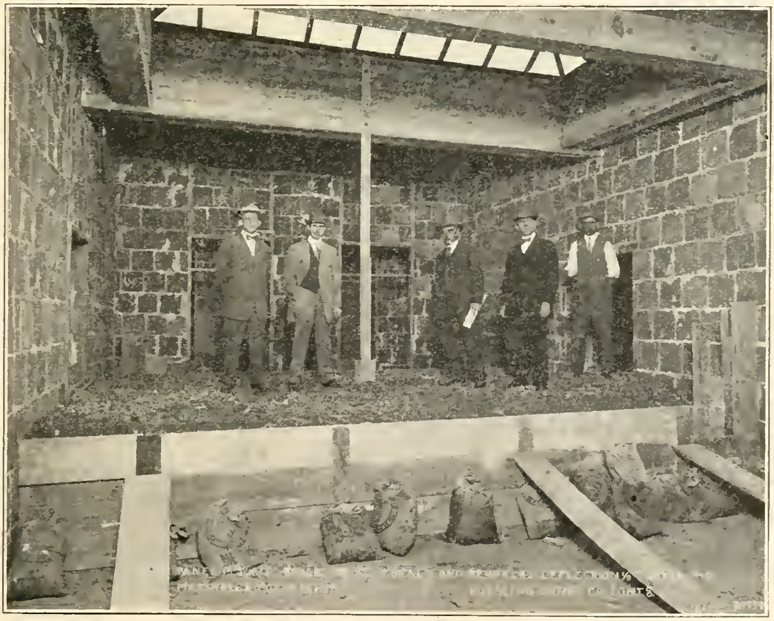

Fig. 2

using unusually large equipment for elevating and spouting concrete. Universal Portland Cement is being used in this work and is being delivered in bulk. If any of our readers are not familiar with methods of handling cement in bulk they would do well to see this plant.

* * *

The Wisconsin-Minnesota Power Co., Eau Claire, Wisconsin, will shortly begin the construction of four large dams across the Chippewa River, near Chippewa Falls. An account of this work will appear in our January issue.

* * *

Work has begun on the concreting operations in connection with the new Union Station; the tower and chutes for spouting concrete are now in place at Madison and Canal Streets. This is an exceptional opportunity to study the construction of this equipment.

* * *

Virgil G. Marani Member Am. Soc. C. E., former Building Commissioner of Cleveland, has issued an interesting booklet containing many helpful suggestions relating to fire protection facilities when formulating a building code. The book lists many tests made upon gypsum, and other interesting information for architects, engineers, manufacturers and contractors.

It is Mr. Marani's belief that there should be a graduated scale of construction from the combustible frame building to the highest type of so-called fireproof building and with this in mind there should also be graduated standard fire tests for these types of construction so that according to the position of any construction in such a graduated scale, this construction would have a definite rate of insurance and definite restrictions as to area, height, and occupancy.

* * *

Notes from the Engineering Societies

The *Western Society of Engineers* have arranged a very attractive program for the Fall, and extends a cordial invitation to all the members of the engineering classes to attend the meetings.

Although the Western Society needs no introduction to the majority of the students of Armour Institute, it may be well to say that it is the forum of engineers in Chicago where vital engineering problems are presented and discussed. Of the speakers to appear are Mr. Earl B. Phelps of the United States Hygienic Laboratory at Washington, Professor W. F. M. Goss, Chief Engineer, Association of Commerce Committee on Smoke Abatement and Electrification of Railroad Terminals, and Mr. B. E. Sunny, President of the Chicago Telephone Co.

* * *

Plans for the National Convention of the *American Association of Engineers* to be held in Chicago December 10-11 are being rapidly completed. All engineering societies have been invited to send official representatives to the convention to join in the discussion and assist in attempts to solve a few of the welfare problems confronting the engineer.

During the latter half of September a gain of 55 members was made. A National Membership Committee has been selected to push the organization of local chapters in various parts of the United States. Those appointed on the committee are: A. H. Krom, Asst. Engr. Ill. State Public Utilities Commission; F. H. Newell, Professor of Civil Engineering University of Illinois; S. Steenerson, Engineer Minnesota Highway Commission, Crookston, Minn.; Edwin R. Webster, Civil Engineer, Marion, Ia.; Daniel B. Luten, Bridge Engineer, Indianapolis; O. L. Dent, Referee in Drainage Matters, Memidja, Minn.; R. A. West, Civil Engineer, Tye River, Va.; Israel L. Beerman, Engineer N. Y. State Highway Commission, Filmore, N. Y.; Harold Almert, Consulting Engineer, Chicago; W. N. Winter, Electrical Engineer, Hood River, Ore.; H. L. Holderman, Civil Engi-

neer, C. M. & St. P. Ry., Lewistown, Mont.; Ernest McCullough, Consulting Engineer, Chicago; George C. Keech, Electrical Engineer, Chicago; A. T. North, Consulting Engineer, Chicago.

* * *

Owing to the increase in its activities, the Association has taken larger quarters at 29 S. La Salle St., Chicago.

Supervision of the work of the Qualification Committee has been undertaken by Ernest McCullough, Consulting Engineer, Chicago. The Service Clearing House is actively engaged in putting the engineer in touch with the employer and the employer in touch with the man without charge. One of the largest electrical manufacturing companies in the United States has given the Association the preference in filling all vacancies which require men of technical training.

* * *

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

President............................John B. Byanskas
Vice-president..........................Bradley S. Carr
Secretary................................E. S. Echlin
Treasurer..........................Lincoln W. Luckow

The opening meeting of the year 1915-1916 was held on October 21, in the Y. M. C. A. rooms, and as per the custom of preceding organizations, a smoker promoted the get-together activities.

President Byanskas, in his address of welcome to the Juniors, explained the advantages of a membership in the Society and gave the outline of the plans for the coming year. Professor Gebhardt followed with a discussion of the outlined plans which propose more open discussion of topics in place of the lectures on a specific subject. In accordance with the plan a subject will be announced in advance of the meetings to be discussed at the meeting by the members.

Following adjournment, refreshments and smokes were served.

On October 1 the Senior Mechanicals made a test on an air compressor used at the Lawndale Station of the Wilson Avenue Tunnel. The test consumed two hours, after which an inspection was made of the tunnel. —*E. S. Echlin.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Chairman .... A. A. Oswald
Treasurer .... H. S. Katz
Secretary .... J. F. Hillock

The year started officially with a smoker held at the Armour lunch-room on Tuesday, September 28, at which about twenty-five men were present. Talks were given by Professors Freeman, Marsh, and Gilbert, which were both instructive and interesting to all. Professor Freemans' remarks were directed chiefly to the Juniors and were concerned with the aims of the A. I. E. E. After the refreshments were served, vacation experiences on the Chautauqua Circuits were well described by Bland, Katz, and Abrams, while Kucera explained the aims of Summer Camp work. The second meeting was held on the 26th of October. On this occasion a new system was tried out with success, according to which dinner was first served in the lunch-room, with the meeting directly following. This gives the men the opportunity of getting home early, as well as affords a congenial half hour or so during supper. The paper presented at this meeting was given by Mr. A. P. Strong, of the Green Engineering Co., and dealt with the "Handling and Storage of Ashes in Power Plants." The talk was exceedingly interesting, especially to those who have power plants to design.

A Membership and Industrial Power Committee have been selected to work in conjunction with the main body. This will be of great benefit to the men, as it will bring them in closer touch with the engineers in the field. The membership committee is to help increase the number of Institute members among those enrolled as local members, and so far eleven such memberships have been secured since the beginning of the college year.

The meetings are open to all Sophomore, Junior and Senior Electricals and Hydro-electricals. The subjects given are instructive and interesting from every view point.

—*J. F. Hillock.*

THE CIVIL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President ....H. A. Rook
Vice-President ....L. J. McHugh
Recording Secretary ....H. W. Hemple
Corresponding Secretary ....R. S. Adams
Treasurer ....F. C. Armstrong

The first meeting of the Society was held in the Y. M. C. A. rooms on October 5, 1915. The important business of the evening was the initiation of the candidates for membership in the Society. The initiation was in the form of an oral quiz, and afforded much amusement to those present. After the examination a light lunch was served, and the cigars and cigarettes added to the sociability. Most of the members and quite a few alumni were present, as were also Professors Phillips, Wells, Armstrong, Dean and Penn.

On October 19, the first lecture of the Society was held in the Engineering rooms. Professor J. C. Penn gave a very interesting talk on "The Construction of the North Avenue Bridge." Professor Penn worked on this bridge and his talk concerned itself with his personal experiences while on the job.

CIVIL INSPECTION TRIPS

On Thursday afternoon, September 16, the Senior and Junior Civils journeyed out to Riverside, Ill., and viewed some concrete roads in the process of construction. The methods of preparing the subgrade, mixing the concrete, laying the reinforcing, and finishing the surface of the road were noted.

On Wednesday, September 29, the Civils inspected the Municipal Pier at the foot of Grand Ave. This pier, extending for a distance of 3,000 feet into the lake, is built on concrete piles and on material filled in by using an hydraulic suction dredge. Except for the roof-arches all steel work is to be covered with concrete. The building is to be of fire-proof construction throughout. Railroad tracks are to be laid on the lower floor of the pier, and the freight is to be loaded from the boats directly into the cars. A recreation spot at the end of the pier will furnish an excellent place from which to fish. Street cars are

to run on the second floor of the building to the extreme end of the pier. The work is under the supervision of the Engineering Department of the City of Chicago.

On Friday, October 16, a trip was made to Kingsbury and Ontario Streets to view the construction of a seven-story reinforced concrete building. The methods used in mixing concrete on a large scale proved interesting. The manner in which the forms were prepared and the way in which the steel reinforcing was laid attracted much attention.

On Thursday, October 21, the Civils spent the day inspecting the construction of the Calumet-Sag Canal. This canal extends from Lake Calumet to join the Chicago Drainage Canal at Lambert, Ill. Its immediate purpose is to serve as a drainage medium for the villages through which it passes. It is being built with the ultimate idea of serving as part of a deep waterway system joining the Great Lakes and the Gulf of Mexico. In building this canal various conditions of soil and rock were encountered. At Worth, Ill., the soil is composed of a soft peat-like substance which is being excavated by means of hydraulic suction dredges. At Lambert solid limestone was encountered which is excavated by drilling and blasting. The work is to cost about $30,000,000, and is under the supervision of the engineers of the Sanitary District of Chicago.

—*H. W. Hemple.*

THE CHEMICAL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President .... G. B. Perlstein
Vice-President .... Goorkey
Secretary .... S. Butterman
Treasurer .... N. Isenberg

The first meeting of the Armour Chemical Engineering Society for the year of 1915-1916 was held on September 10, 1915, being rather brief and hurriedly called for the disposition of certain matters remaining from the preceding college year, and attended by only the Senior members. There followed a discussion of some length as to the nature of the topics to be discussed before the Society and as to the persons to be called upon

to deliver such talks. It was decided in this connection that the policy would be to depend upon speakers other than student members of the Society, and accordingly the arrangement is being made for a series of interesting lectures to be delivered by members of the faculty of the Chemical Engineering Department, and by professional men engaged in the practice of Chemical Manufacturing, etc.

The second meeting was held on October 7, the first address being made before the Society by Professor McCormack. All of the Seniors were present and also a good representation from the Junior class. Professor McCormack addressed the Society on "The Chemical Problems of Today," presenting the present status of the chemical industries in America, particularly in its relation to the European War. He pointed out the shortage of inorganic chemicals on the American market due to the cutting off of importation from Germany, and its effect on the organic chemical industries, such as the manufacture of dye-stuffs and explosives. The great shortage of fuming sulphuric acid, heretofore obtained in large quantities from Germany, was greatly felt on account of its rather extensive use for normal manufacture, the demand being intensified by the present situation, sulphuric acid playing a major part in the nitration processes for the production of explosives. The talk further brought out the fact that in connection with the destructive distillation of coal the tendency is to work the distillate (coal-tar) for benzol, which is subsequently converted into phenol through a synthetic process. The latter product is a basis of the manufacture of picric acid for high explosive shells and rifle ammunition. Professor McCormack had samples of the products corresponding to the various stages in the transformation of crude oil or tar into picric acid, as prepared under his direction in the laboratory of the Chemical Department. The talk was followed by an informal discussion in which several new features were brought out.

The meeting was adjourned after the Society had tendered a vote of thanks to Professor McCormack for one of the most interesting evenings the Society has yet enjoyed.

The third meeting of the Society was held in the Physics Lecture room on November 4 with a record attendance. It was pleasing to note that the enthusiasm was not restricted to students

in the Chemical Engineering course, but extended to other departments as well. The meeting was called to order by the President at 4 o'clock, and all business was promptly dispensed with in order to allow ample time for the lecture, which was of course the main object of the occasion. Professor Freud, in collaboration with Dr. Doubt, delivered a theoretical and experimental lecture on "The Structure of the Atom." Professor Freud developed the physical and chemical theories which are the basis for the modern conception from the viewpoint of the electron, conducting the investigation by the aid of mathematical demonstrations and the acts established by the various illustrious workers engaged in the evolution of this new idea. The task which he has set himself to perform was to classify and organize the evidence arising out of mathematical reasoning and substantiated by the facts established by ingenious experimental investigation, interpret it, and show that all of the arguments lead to the idea of the "positive-nucleous atom." During the course of the lecture the various points of significance were illustrated by stereopticon views, while Dr. Doubt demonstrated the interesting properties of the electrons by such experiments as the discharge of high frequency current through a vacuum, exhibiting the ability of the electrons to produce motion through impact, to produce heat through the arrest of motion, to cause certain substances, in some unknown manner—chemical or otherwise—to phosphoresce, etc. The talk brought out, further, that from the disturbing effect of an electro magnetic field on the spectral lines of an element there has been deduced empirically a mathematical formulation in which there occurs, for any one element, a characteristic value—the atomic number, a new constant of fundamental significance, by means of which the position of the atoms in the Periodic System can be decided with great precision, affording a more delicate criterion than the mere sequence of the atomic weights, and obviating the discrepancies which existed heretofore. This feature is, of course, of special interest to the chemist.

As a comment on the nature of the lecture, it must be said that its authors are deserving of an acknowledgement of appreciation for its unusual preparation and for the enthusiasm revealed in its conduct. —*S. Butterman.*

THE FIRE PROTECTION ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President ....L. Peterson
Vice-President ....W. A. Tronvig
Secretary ....A. Corman
Treasurer ....R. F. Schreiner

The Fire Protection Engineering Society held the first meeting of what promises to be its most prosperous and eventful year on Friday, October 8th. President Peterson delivered a very unique opening address, setting forth the objects and aims of the Society, after which the main business of the meeting was discussed. This was the setting of a day for our business meetings and a day for the practical talks or lectures on the field of Fire Protection.

After an enthusiastic discussion by all members present, the day for the business meeting was decided to be the second Tuesday of each month and that for the lecture on the fourth Tuesday. President Peterson then made a very urgent request to all members present to attend the monthly lectures with as many friends as possible.

Too much cannot be said concerning these lectures. They are given by very competent and experienced men in the broad and ever-increasing field of Fire Protection and involve a discussion of the practical side of that profession. They are not only of interest to the Fire Protection Engineer but also very instructive and interesting to all engineering students. Therefore, the Fire Prevention Engineering Society extends a very cordial invitation to students of all courses to attend. Don't forget to keep the fourth Tuesday of every month open and attend a lecture which will surprise you with the opportunities and far-reaching interests of the Fire Protection Engineer.

—*A. Corman.*

A SELECTED LIST OF BOOKS RECENTLY ADDED TO THE LIBRARY OF THE COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING.

Davey, Norman. The Gas Turbine. New York, D. Van Nostrand Co., 1914.

Furman, Franklin De Ronde. Valves and valve gears. New York, J. Wiley & Sons, 1915.

V. 1—Steam engines and steam turbines.

V. 2.—Gasoline, gas and oil engines.

Heldt, P. M. The gasoline automobile; its design and construction, New York, The Horseless Age, 1915.

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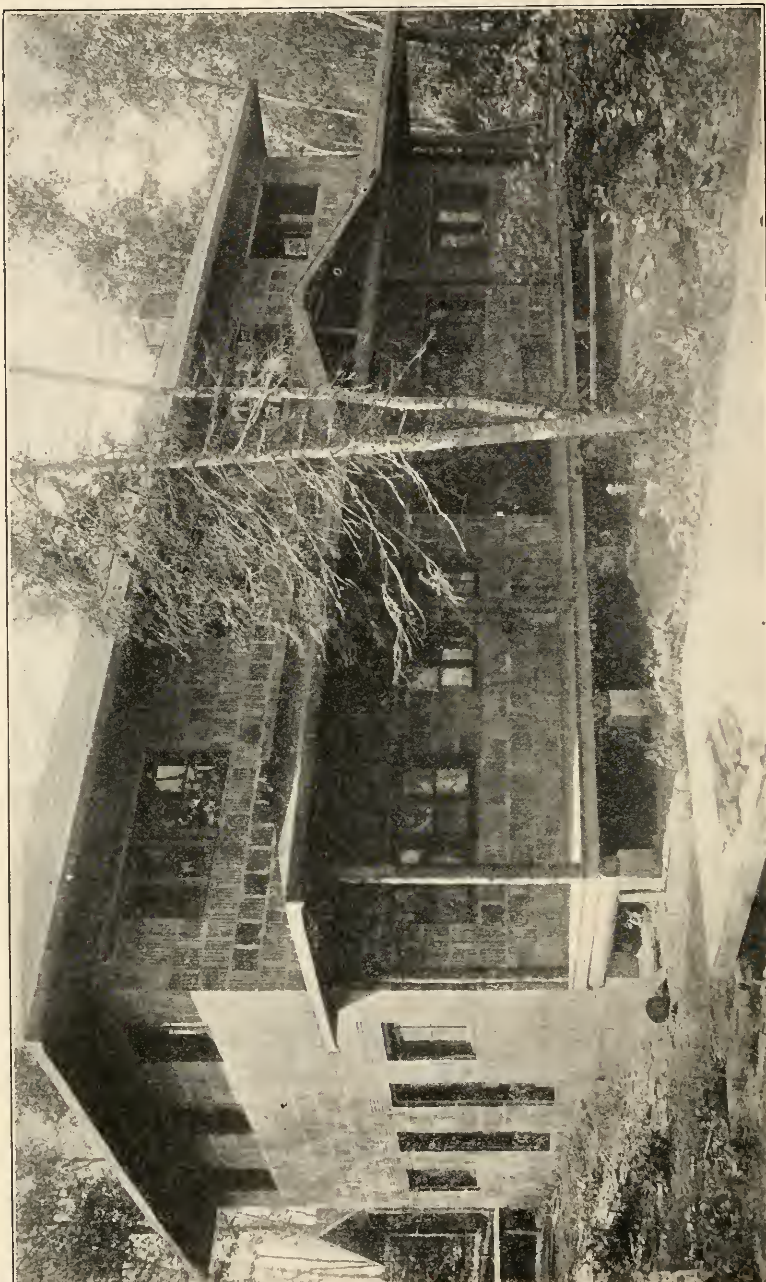
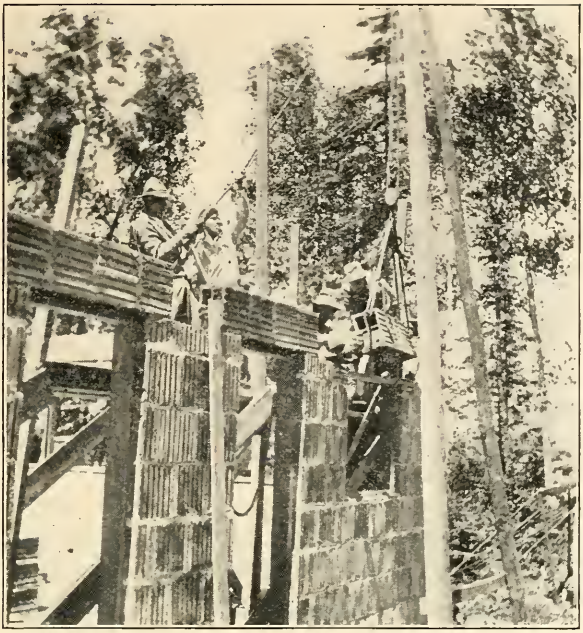
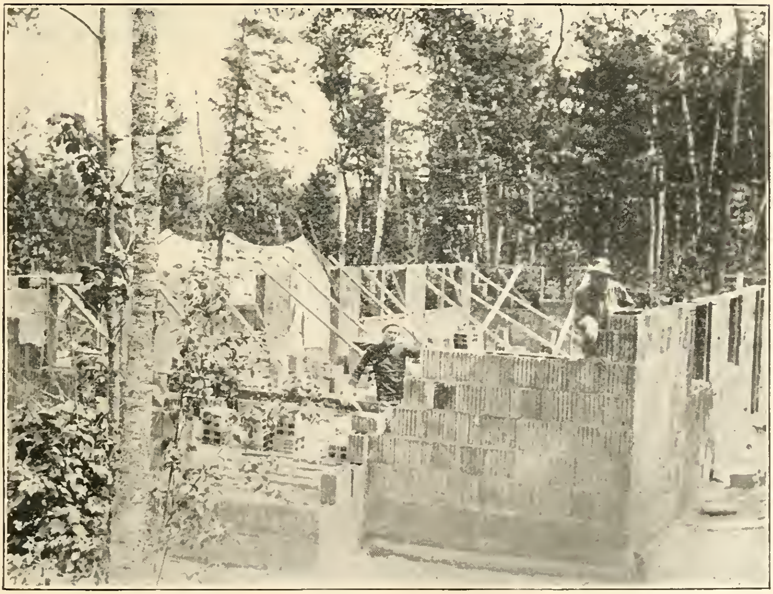


The Administration Building—Camp Armour



Setting Lintels



Who are the Tile-Setters?

THE ALUMNUS

Being That Part of **The Armour Engineer** Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

T. A. Banning, Jr. F. T. Bangs W. A. Kellner

Communications should be addressed to T. A. Banning, Jr.
1632 Marquette Bldg., Chicago, Ill.

THE MID-WINTER BANQUET

Complete arrangements have not yet been made for the annual mid-winter reunion and banquet. However, the date has been fixed as Saturday evening, December 18, and the banquet will be held at a downtown hotel.

The committee in charge of the arrangements is paying attention to every detail in an effort to excel in character similar banquets in preceding years. The committee is trying to better the entertainment to be provided, the banquet service and the

appointments; in fact, they will try to increase everything but the price per plate.

Detailed announcements will be made later. Just now all that is necessary is for you to reserve the time—Saturday evening. December 18—for a good time.

SCHOLARSHIP LOAN FUND

The last report of the chairman of the Loan Fund Committee shows funds again available for loans to deserving members of the student body at Armour Institute. Last spring no funds were available for this purpose, but since that time there has been received a donation of $50, money for several life memberships in the Association and considerable money from payment of loans.

E. F. Hiller, who has done excellent work as chairman of the committee during the past few years, has resigned as chairman but has been retained as a member of the committee. The chairmanship is now in the hands of L. J. Byrne, '04. Stanley Dean remains a member of the committee.

Applications for loans should be made to L. J. Byrne, care of Maher & Byrne Co., Otis Bldg., or to Stanley Dean, Armour Institute.

THE SPRING MEETING OF 1915

The reunion was held Saturday afternoon and evening, May 22, 1915, at Armour Institute. One of the few clear days of a rainy spring happened to be chosen and the festivities began at 3 o'clock with a baseball game between the Alumni and the "Tech" team. The Alumni put up a good game against one of the best teams that ever represented A. I. T. on the diamond, the "Techs" being one run in the lead when the game was called at the end of the seventh inning.

Teams representing the even and odd-numbered classes indulged in a tug-of-war. The "odds" seemed to have the "evens" coming their way until the rope broke, sending some of the boys sprawling and furnishing high-grade amusement for the spectators. It took 5,800 pounds tension on the big testing ma-

chine to do the same trick. Everybody guessed, A. L. Arenberg, '13, proving the best and securing the prize. That figure, however, remains low as an estimate of the Armour grads' pulling strength.

The banquet pulled an attendance of over 200, and the gymnasium was very comfortably filled. Attendance of the classes was as follows:

Class	Present	Per Cent Present	Class	Present	Per Cent Present
1897	1	12.5	1907	12	34.3
1898	0	0	1908	3	8.8
1899	4	30.8	1909	9	19.5
1900	0	0	1910	10	27.7
1901	2	28.5	1911	11	21.1
1902	9	60.0	1912	8	16.1
1903	2	11.1	1913	20	26.3
1904	8	44.4	1914	16	20.0
1905	9	34.6	1915	49	
1906	10	23.9			

The cup for the highest percentage of class numbers present was awarded to the class of 1902 for the ensuing year. The cup for the class having the greatest paid-up membership was retained by the class of 1899.

After a blessing was asked by Dr. Gunsaulus the guests turned to the business of eating, interrupted frequently by songs and class cheers. At the conclusion of the meal Dr. Gunsaulus gave a very interesting address of welcome to the Association. Dean Raymond was next "introduced," and talked on the high standards of Armour Institute. An interesting feature which he presented was a classification of the graduates into the various branches of business endeavors pursued.

Master of Ceremonies T. A. Banning, Jr., gave an address of welcome to the guests of the evening, the graduating class of 1915. The class president, C. A. Kneupfer, answered for his fellow classmates.

President Heuchling spoke briefly of the plan for the celebration of the twenty-fifth anniversary of the founding of Armour Institute. E. O. Griffenhagen explained the plans more fully and urged every one to help make it a great success. Much enthusiasm for the scheme as shown during his animated elucidation of the plan. A pledge, guaranteeing the purchase of a

$10 ticket to be paid in installments, was passed around and was signed by all present.

The Armour Quartette rendered several excellent selections, including a new Armour song by Prof. W. G. Smith.

The feature of the evening's entertainment was an illustrated lecture given by Frederic O. Bemm, official photographer of the Art Institute of Chicago, on "Colored Photography." His collection of colored slides, especially those of the Grand Canyon of the Colorado, was truly wonderful. His talk and the pictures were highly appreciated.

The business meeting of the Association was called to order by President Heuchling. Owing to the lateness of the hour, the reports of officers and committees were dispensed with, and the election of officers held. The entire slate presented by the Nominating Committee found no opposition, and the following officers were unanimously elected:

President ....Thomas A. Banning, Jr., '07
Vice-President ....W. A. Kellner, '10
Treasurer ....H. E. Beckman, '09
Corresponding Secretary ....Stanley Dean, '06
Recording Secretary ....E. M. Sincere, '12
Master of Ceremonies.........Allen B. Benedict, '04
Members of Board of Managers to 1918—
............................E. F. Hiller, '06
............................T. J. Byrne, '04
........................F. G. Heuchling, '07

After adopting a resolution endorsing the proposed celebration in 1918 the meeting adjourned.

AMENDMENTS TO THE CONSTITUTION AND BY-LAWS OF THE ARMOUR ALUMNI ASSOCIATION

Since the last meeting of the Association two amendments to the constitution have been under discussion by the Board of Managers. These amendments have been incorporated in resolutions which will be submitted at the mid-winter meeting in substantially the following form:

Resolution No. 1

Be it resolved by the Board of Managers of the Alumni Association of Armour Institute of Technology that the constitution of said

Association be, and the same is, hereby amended as follows:

By striking out Section 3 or Article 6 and substituting therefor the following:

> Section 3. All former technical college students who have successfully completed the equivalent of one year's work at the Institute and all members of the faculty of Armour Institute of Technology shall be eligible to associate membership. Associate members shall have all the privileges of the Association except holding office.

Resolution No. 2

Be it resolved by the Board of Managers of the Alumni Association of Armour Institute of Technology that the constitution of said Association be, and the same is, hereby amended as follows:

By striking out Section 1 of Article 5 and rewriting said article as follows:

> Section 1. The annual meeting of the Association shall be held during the months of May or June and there shall be a mid-winter meeting during the month of December. The places of these meetings shall be fixed by the Board of Managers.

Resolution No. 1 provides for the substitution of the words "successfully completed the equivalent of one years' work" for the words, "completed two years' work."

Resolution No. 2 provides more latitude as to the dates of the annual and mid-winter meetings. Under the present constitution the annual meeting must be held within ten days prior to the graduating exercises, and the mid-winter meeting must be held during the week preceding Christmas. The purpose of the amendment is to permit the spring meeting to be held during Junior week.

ADDRESSES

In a recent revision of the mailing list of graduates of Armour Institute it was unable to secure proper addresses for the graduates listed below. Anyone knowing the whereabouts of any of these men will confer a favor by informing Stanley Dean, care of Armour Institute of Technology.

A. G. Anderson, C. E. .... '10
H. C. Anderson, C. E. .... '09
H. J. Ash, E. E. .... '05
O. C. Badger, C. E. .... '13
A. E. Bredlau, C. E. .... '11
W. L. Brock, M. E. .... '06
W. W. Charles, Ch. E. .... '02
P. E. Chatain, Ch. E. .... '09

N. L. Edson, M. E. ....'06
R. T. Evans, M. E. ....'09
G. W. Fiske, M. E. ....'05
C. J. Furay, Arch. ....'13
P. Harrington, E. E. ....'06
F. G. Hazen, E. E. ....'12
W. K. Howenstein, Arch. ....'10
H. F. Israel, C. E. ....'13
Charles Kopald, E. E. ....'13
C. D. Lundblad, Arch...................'13
E. McBurney, Jr., M. E. ....'05
H. A. McClyment, E. E. ....'98
A. W. MacMillan, M. E. ....'05
W. J. Neville, E. E. ....'10
F. G. Pease, E. E. ....'01
V. S. Persons, C. E. ....'02
E. M. Ruede, E. E. ....'10
W. J. Saunders, E. E. ....'07
Fred Schmidt, C. E. ....'12
J. N. Schumacher, Ch. E. ....'06
W. C. Thatcher, E. E. ....'10
W. E. Thomas, M. E. ....'10
A. W. Taylor, E. E. ....'05
F. J. Urson, Jr., C. E. ....'09

ALUMNI NOTES

1897.

F. C. Johnson, formerly of the faculty of the Florida A. & M. College, is now teaching in the Mechanical Arts Department, North Carolina Agricultural and Technical College, Greensboro, N. C.

1898.

E. H. Naglestock will be missed in Chicago and at Alumni Association meetings. He is now located in Tremont, Neb.

1899.

C. O. Ransom is now vice president of the James & Manchester Co., 840 Leader Bldg., Cleveland, O.

S. C. Fiddyment is now with the Shepard Engineering Co., Williamsport, Pa.

R. S. Huey, formerly assistant superintendent of plant, Universal Portland Cement Co., Buffington, Ind., is now superintendent of plant for the same company at Duluth, Minn.

1900.

C. H. Fisher is a schedule rating expert, with offices at 38 Clinton Street, Newark, N. J.

1901.

W. R. Ruegnitz, formerly examiner, Continental Insurance Co., is now superintendent, Bates & Rogers Construction Co., 206 Lindelle Blk., Spokane, Wash.

1902.

B. F. Eyer, formerly professor of electrical engineering, Kansas State Agricultural College, is now consulting engineer and general manager of the Marshall County Power & Light Co., Manhattan, Kan.

S. E. Schafer is now sales engineer, Chain Belt Co., Milwaukee, Wis.

E. L. Wallace, formerly assistant examiner, United States Patent Office, is now patent attorney, 639 Westly Roberts Bldg., Los Angeles, Cal.

1905.

Frank C. Clark, assistant engineer, Department of Construction and Engineering, Panama Canal, for several years during the construction of the Canal, is now superintendent of the Pacific Locks, Pedro Miguel, C. Z.

W. A. Ratcliff is now in the employ of the Worden-Allen Co., bridge builders and contractors, 208 South La Salle Street.

A. R. Redman is now connected with the Railroad Commission of California. His address is 450 Broadway, Glendale, Cal.

J. K. Thompson is superintendent, Witherspoon-Englar Co., contractors, Monadnock Blk., Chicago.

1906.

Einar Enander, formerly instructor in mechanical drawing, Farragut High School, is now employed in the engineering department, Public Service Co., Chicago.

1907.

E. A. Blumenthal is now president of the Gabriel-Soubbed Co., 1129 Michigan Blvd., Chicago.

C. S. Henning, Jr., is now division engineer, Oregon Short Line Railroad, Anthony, Idaho.

Theodore Wachs is vice president and superintendent, Banroth Machine & Tool Co., 454 Earle Street, Toledo, O.

The president of the United States can only anticipate becoming what our genial president of the Alumni Association, T. A. Banning, Jr., now is—a married man. The happy event occurred October 23, 1915, and our heartiest congratulations are extended to the bride and groom.

1908.

E. W. Adams, who is employed by the Western Electric Co., has returned to this country and is in the New York office, 463 West Street. Mr. Adams was in Antwerp at the beginning of the war and after the Belgian invasion went to London, where he remained for some time until returning to the states.

F. S. Collins is selling Western Electric and Wagner motors, headquarters at Chicago.

R. G. Grant is now in the engineering department, Merchants' Heat & Light Co., Indianapolis, Ind.

G. C. Burge, for many years chief draftsman, The Arnold Co., Chicago, accepted a similar position last May with the New York Steam Co., New York City.

H. W. Nichols is now research physicist, Westinghouse Electric & Manufacturing Co., Maplewood, N. J.

R. C. Ostergren is member of firm, Hall & Ostergren, Architects, 911 City Hall Square Bldg., Chicago.

P. J. Pahlman is now instructor in applied electricity, Lane Technical High School, Chicago.

S. A. Souther is county treasurer of Custer County, Montana.

G. H. Wilsey is structural engineer, St. Paul Union Depot Co., St. Paul, Minn.

1909.

L. N. Bexton, motor inspector, Union Pacific Railway, is now stationed at North Platte, Neb.

Manierre Dawson has left Chicago and is now in Ludington, Mich.

A. R. Perrine is now a member of the faculty, Georgia School of Technology, Atlanta, Ga.

Herbert Rose is now employed in the construction department, Swift & Co., Chicago.

R. A. Walther is working in the county engineer's office, Waukegan, Ill.

F. C. Zanzig is now engineer, Benedict Electric Co., 117 West Water Street, Milwaukee, Wis.

1910.

A. L. Bergbom, formerly draftsman with the Chicago, Milwaukee & St. Paul Railway, Minneapolis, Minn., is now in the Bridge Division, City of Chicago, 2001 City Hall Square Bldg.

William Clarkson is now assistant engineer, Oil City Iron Works, Corsicana, Tex.

M. Kallis is special agent, Aetna Life Insurance Co., 901 Harris Trust Bldg., Chicago.

R. A. Leavell is now instructor, Iowa State College, Ames, Ia.

F. M. Pfaelzer is now vice president, Bernhard Pfalzer & Sons, 4000 South Halsted Street, Chicago.

Frank R. Squair has resigned as assistant examiner of patents, Patent Office, Washington, D. C., and hung out his shingle as patent attorney, McLachler Bldg., in the capital city.

1911.

T. G. Cleaver is now manager, The Master Builders Co., 705 Merchants Bank Bldg., Chicago.

W. W. Drew is superintendent of traffic, Western Union Telegraph Co., Chicago.

P. R. Hynes is junior engineer, Bridge Department, City of Chicago.

E. D. Kaiser is back in Chicago working for the Hughes Electric Heating Co., 215 West Schiller Street.

W. P. McGuire is doing valuation work for the Interstate Commerce Commission, Chicago.

J. K. Mabbs, who had been with the Commonwealth Edison Co. since his graduation, accepted an appointment last May in the Department of Electricity, City of Chicago.

Ignatius Sears is now engineering draftsman, Bridge Designing Division, City of Chicago.

1912.

S. C. Anderson, formerly designer and detailer with the Chicago, Milwaukee & St. Paul Railway, Chicago, is plant engineer,

Standard Oil Co., Wood River refinery. His address is 424 Bluff Street, Alton, Ill.

R. B. Clark has been promoted to the position of production manager, Hardinge Conical Mill Co., 50 Church Street, New York City.

H. A. Drew is now inspector, Edison Storage Battery Co., 2025 Michigan Avenue, Chicago.

R. J. Geisler is now located in St. Louis and is district manager, Mathews Gravity Carrier Co.

E. R. Roleson has gone west and is now chemical engineer, Gould & Ash, 319 Monadnock Bldg., San Francisco.

R. R. Ross is now in the employ of the Nebraska Telephone Co., Omaha, Neb.

N. W. Strale is now in St. Louis as engineer for the Laclede Gas Light Co. His address is 3819 Shenandoah Avenue.

T. F. Wolfe has accepted an appointment as junior engineer, Waterpipe Extension Department, City of Chicago, 404 City Hall.

1913.

J. D. Bradford, who has worked for the H. Koppers Co., 5 South Wabash Avenue, Chicago, since his graduation, was transferred to the Pittsburgh offices of the company last spring. The transfer was a promotion and we offer congratulations. He made the trip from Pittsburgh to be present at the spring meeting of the Alumni Association.

W. T. Braun, Jr., is now instructor, Coyne Trade School, 39 East Illinois Street, Chicago.

A. C. Cramer has been transferred to the downtown office of the Chicago, Milwaukee & St. Paul Railway, Chicago.

C. W. Garrison is business manager, Ford Family Publishing Co., 910 South Michigan Avenue, Chicago.

Kazimir Gugis is president of the United Lithuanian Societies of Chicago, 127 North Dearborn Street.

A. F. Holden, Jr., is with the Fire Underwriters Inspection Bureau, 551 Sherlock Bldg., Portland, Ore.

G. F. Irving is now in the engineering department, Greater Winnipeg Water District, 901 Boyd Bldg., Winnipeg, Man.

A. C. Lill, formerly with the Kalamazoo Power Co., is assistant in testing division, Chicago Avenue Pumping Station, Chicago.

Philip Meyer is now assistant engineer, Concrete Steel Co. 1106 Monadnock Blk., Chicago.

D. M. Stump is employed in the efficiency department, Montgomery Ward & Co., Chicago.

1914.

C. C. Boetter has left the employ of the Chicago, Burlington & Quincy Railroad and is now working for the Interstate Commerce Commission, 914 Karpen Bldg., Chicago.

Glenn Carnahan is assistant chemist, Peoples Gas Light & Coke Co., Chicago. His address is 3251 Michigan Avenue.

Joseph Cohen is working for Henry L. Newhouse, architect, 4630 Prairie Avenue, Chicago.

John R. Charlton is now employed by the American Telephone & Telegraph Co., equipment department, Bell Telephone Bldg., Chicago.

E. J. Hepp, formerly in the Chicago offices of the Underwriters Bureau of Middle and Central States, is now in the New York office, 1 Liberty Street.

Harry Himelblau is mechanical draftsman, Illinois Traction System, Peoria, Ill.

Louis Hirsh is assistant to actuary, Security Life Insurance Co., The Rookery, Chicago.

John C. Hollowed is in the estimating department, Great Lakes Dredge & Dock Co., Chicago.

M. I. Levin is rodman, Bridge Department, City of Chicago, City Hall.

Meyer Willens is inspector of building construction, South Park Commission, Chicago.

I. Wishnack is chemist, Magnesia Products Co., 602 West Austin Avenue, Chicago.

Leonard Zeman has entered the service of the United States Navy and is stationed at the Brooklyn Navy Yard.

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GOOD ROADS SECTION

At the second special session of the Forty-ninth general assembly which was called January 5. the State of Illinois is to be asked to authorize a state bond issue for road improvement. Governor Dunne at a recent meeting said that this would be the newest feature of the second call and although he did not indicate the size of the bond issue that he will recommend, the lowest figure of $100,000.000 may be presumed. This figure may be doubled or tripled as it is understood that $200,000,000 already has been issued in bonds by the state of California and $250,000,000 is the approximate size of the state bonds of the State of New York.

The good roads section presented will therefore be in line with the past good roads agitation and the agitation which will result from any such bond issue. Although the section does not include the many different types of pavements it is not the intention to advocate the merits of any particular kind of pavement but the desire is to present the careful and practical study of the subject made by the manufacturers, determining the factors to be considered and the mistakes to be avoided in street pavements.—The Editors.

SYSTEMATIC INSPECTION OF BITUMINOUS PAVEMENTS

BY T. C. FORD, CH. E., A. M.

Asst. Mgr. and Chief Chemist, The Pioneer Asphalt Company, Lawrenceville, Ill.

The ever increasing demand by the public for more and better roads has acted as a wonderful stimulus to colleges and engineers to prepare themselves to solve the many problems confronting the highway engineer in the construction of modern roads and pavements. The lasts five years have been the greatest years of road building in the history of our country, not alone in our country, but in the world. The demand upon the colleges for courses of instruction in highway engineering has become so great that a majority of the technical schools are now giving at least a short course in this branch of engineering as an auxiliary to the course in civil engineering.

Numerous societies such as the International Road Congress, American Society of Municipal Improvements and the American Society of Civil Engineers have devoted much time to the subject of roads and pavements. Standard specifications have been

adopted covering the chemical and physical properties of the materials to be used and specific directions for the methods of construction. These specifications are the work of the most prominent highway engineers and chemists of our country and are based upon the experience of these men in their practical and theoretical work. A careful study of the roads and pavements of our country and the methods of their construction proves conclusively that the standard methods of construction will give most excellent results. However, it is a grievious fact that, with all the work that has been done and the many experiments that have been conducted to determine the best materials and the best methods of construction, there are still many failures of roads and pavements. Where then is the trouble?

It has long been recognized by many engineers and is now becoming generally acknowledged that the principal causes of these failures are the improper handling of the materials and the failure to adhere to the essential requirements of the standard specifications. This may be due either to carelessness, greed of the contractor, or ignorance. The many small but important details of construction are thus too often neglected. The writer has had occasion to examine many pavements throughout the United States and Canada and has found, almost without exception, that failures are due to the above causes.

The effect of carelessness was well illustrated on a sheet asphalt pavement in a western city. The mixture in this instance was allowed to lay until it was entirely too cold to obtain the proper compression before it was rolled, then in order to remove the "honey combs," red hot smoothers were used which actually set fire to the asphalt. The result was that there was very poor compression and many places of the surface were burned which caused rapid disintegration of the pavement, forming many holes and a very uneven surface.

The greed of the contractor too, also often causes skimping of material and workmanship which results in inferior and faulty pavements. The author once had occasion to examine a sheet asphalt pavement being laid by a large construction company in a western city and found that it was laying a very non-uniform and very unsatisfactory mixture. The temperature varied from 200°F. to 500°F. causing a non-uniform mix in the former and a burned one in the latter instance. Analysis of samples

showed insufficient bitumen and filler, with a very poor sand grading. One eight-ton roller was forced to roll the output of two large railroad plants with the result that the mixture only received about one-half the rolling necessary and a very large proportion of it was entirely too cold before the first rolling was given. When a protest was made to the manager of the company he replied that a very successful contractor who worked by "rule of the thumb" method claimed that all that was necessary in a mixture was to "make it black." He was then very forcibly reminded that the mixture which his plants were then turning out did not even come up to this requirement as it was either gray from the uncoated sand or burned brown from the excessive heat. It was simply a matter of greed, they were trying to turn out a maximum amount of work with the cheapest possible mixture and the least possible labor. The result was that the first heavy fall rains washed several blocks of the pavement into the gutter.

Last year the asphalt macadam on the Royal Oak Road leading out of Detroit was reconstructed by the Michigan State Highway Department under the supervision of an engineering company of which the writer was then a member. This road way had been built about two years previously by a contractor who had no experience in the construction of bituminous pavements and without competent inspection. The result was that in a very short time the pavement went to pieces. An examination of the roadway showed that the foundation had been very poorly constructed, having been insufficiently rolled and filled as shown by the depression in it. The stone in the top course which should have been of a uniform size was anything but uniform, varying from that which would pass a half-inch mesh to that which would not pass a three and a half inch mesh. The bitumen was very unevenly distributed. Many places appeared to have about three gallons per square yard and others less than a gallon. Analysis of samples taken from different places in the pavement confirmed these appearances.

Fig. I shows the condition of this roadway just prior to its reconstruction. The uneven surface caused by the poorly graded stone and the uneven distribution of bitumen is shown very clearly in this illustration. The condition of the road was such that it was impossible to economically repair it by the penetra-

tion method, so it was deemed advisable to take up the surface, even the foundation and replace the surface with a hot mixture. This was done by taking up the surface and re-heating it in a suitable mixture with the addition of sufficient new stone and asphalt to produce a good and uniform mixture. Fig. II shows the machinery in which the mixture was re-heated and Fig III the mixture as it was spread on the pavement. This illustration shows very well the uniformity of the mixture which was used. This reconstructed road is in excellent condition today notwithstanding the fact that it has exceptionally heavy automobile and horse-drawn traffic. Fig. IV shows the completed pavement after it was opened to traffic. The cost of the inspection of this road was very nominal and as this same nominal eexpense two years previous would have saved the entire cost of this reconstruction, there is no comment needed to show the value of careful and efficient inspection.

A prominent chemist has recently said in an article on the subject of inspection that "Given a bituminous road to build, there must be some one on the job who knows." Too often incompetent and ignorant inspectors are placed on bituminous work with the result that contractors are forced to carry out unimportant details and allowed to neglect the vital ones. An inspector of this class one time insisted on about fifty yards of completed sheet asphalt pavement being taken up and a thin coating of clay being swept from the concrete at a street intersection and the same day be allowed a load of top mixture to be laid at a temperature of over 500°F.

Many plans of inspection are now being used by engineering companies, but it is the opinion of the author that one of the most efficient is that used by the company mentioned above. This system covers every essential detail of construction from the beginning to the completion of the work. The following outline gives the essential features of this system:

Preliminary examination of materials.

Starting the work.

Local inspection.

Daily samples and reports.

Testing of materials.

Abstracts of work done.

Paving record.

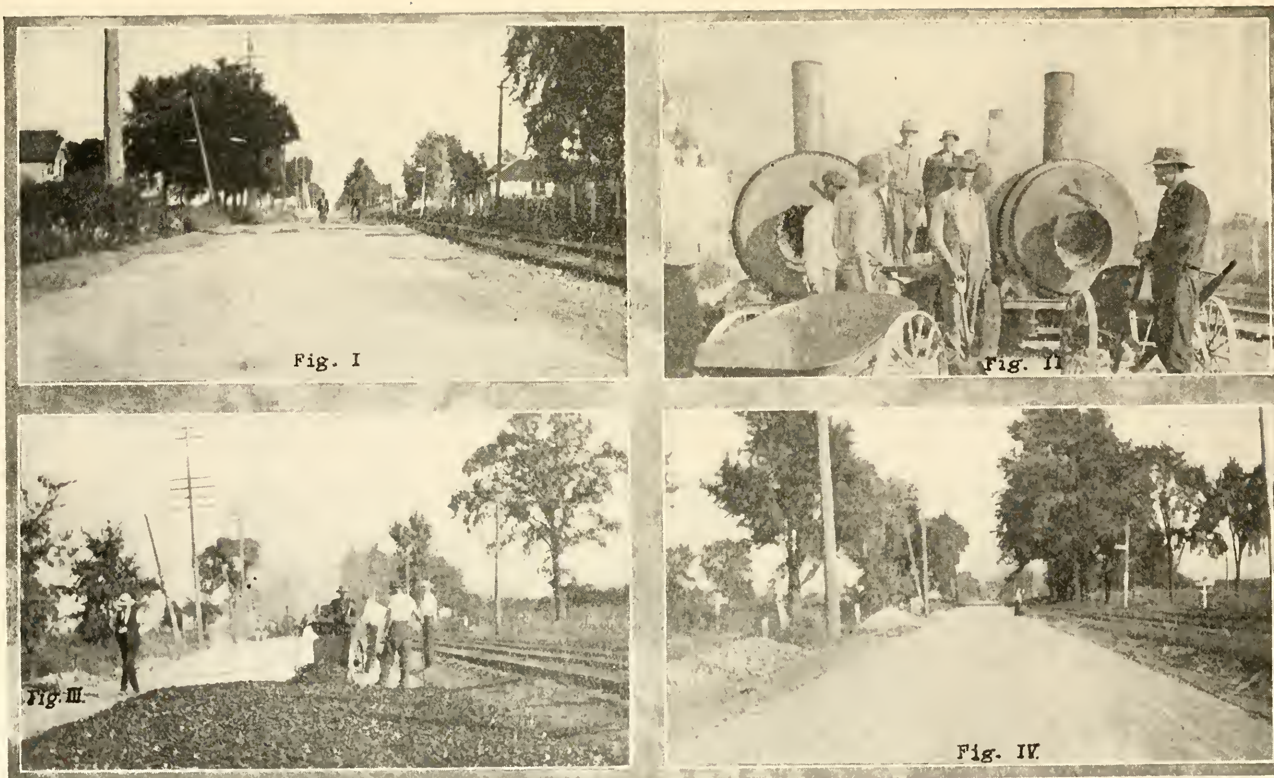


Fig. I

Fig. II

Fig. III

Fig. IV

As shown by the above outline this system provides for a preliminary examination of all materials to be used in the construction work. This examination includes all bituminous materials, samples of which usually accompany the bids, stone, sand, limestone dust and any other material entering into the surface mixture. From the result of these tests the quality of each material is determined and then by comparing the cost of each, it may be determined which materials are the most economical to use, and the proportions of each to be used in the mixture.

After it has been determined what materials are to be used, the next essential feature is to get the work properly started. Much time, money and trouble may be saved by having a job started right. At the beginning of the work a member of the engineering firm was present to set the mix and to see that it worked satisfactorily, and to assist in every possible way to get a first pavement. There are many factors which determine a proper bituminous mixture that really require the assistance of an expert in this line of work. The local conditions in each city, the qualities of the materials entering into the mixture, the machinery, the contractor and his organization each has its influence on the results obtained and it is of the utmost importance that all factors be harmonized in order to obtain the best results. Having a representative on the work when it is started gives the engineering company the opportunity of becoming familiar with all of the above-mentioned factors, and this knowledge materially assists in overcoming the many difficulties which arise during the progress of the work.

The city or county engineer places an inspector on the work and this man is fully instructed in his duties which are to keep in close touch with all that is going on, check the amount of the different ingredients entering into the mixture and see that they are kept uniform, take temperatures of the mix, take all necessary samples and forward to the main laboratory and make out daily reports.

Daily samples of the mixture and the asphalt cement are taken and forwarded to the laboratory where they are tested, the mixture, for bitumen and grading of the mineral aggregate, and the asphalt cement for penetration. Report blanks are filled out by the local inspector and contain all detailed information covering the mixture used, location from which the samples

were taken, temperatures, date and etc. When samples reach the laboratory they are immediately tested and reported with recommendations to the engineer or official designated by the city.

Great care is taken to identify each sample both the plant and laboratory number being given on the report sheets. This precaution saves much confusion and any misunderstanding regarding what sample is being referred to in the reports.

All shipments of asphalt, flux, sand and stone are sampled and tested to see that they are suitable for the work and come within the requirements of the specifications.

At the end of each ten days abstracts are made of the work done during this time. These abstracts give complete information regarding the analysis of the daily samples, the ingredients in the mixture used each day, the amount of material used and the yardage laid. These reports enables one at a glance to get a comprehensive idea of the general quality of the work being done.

After the completion of the work a member of the engineering firm personally inspects all pavements laid and makes a report with recommendations to the city officials.

One of the most valuable features of this system is The Paving Record, which is a bound volume containing a complete record of all analysis made, copies of the abstract reports, a discussion of the general character of the work, a description of the machinery used, an outline of the contractors organzation, a complete report on the condition of the pavements laid with recommendations to the city officials and a copy of the specifications to the city officials and a copy of the specification under which the work was laid. The value of this record cannot be too highly estimated as it gives in detail a complete record of the work so that at any time in the future any data required may be easily and readily obtained. If such records had been kept on all the bituminous pavements laid in our country, it would have saved our chemists and engineers an endless amount of work in acquiring the necessary knowledge for the construction of successful pavements.

ASPHALTIC HIGHWAY CONSTRUCTION

BY DANIEL T. PIERCE

Executive Assistant, The Barber Asphalt Paving Company, Philadelphia.

It is natural enough that road builders should have turned to the various forms of asphaltic construction, for when the building of hard-surface roads began on a large scale seven or eight years ago, there were fully 200,000,000 square yards of asphaltic pavement in the United States.

The asphalt country road is merely the adaptation of what has been learned in 35 years of street construction applied to highways. The main difference between the two forms of construction is that the stone aggregate of the country highway is coarser than that of a sheet asphalt pavement. The principle is the same, namely that of a wear-resisting aggregate cemented together with bitumen, thus producing a plastic, resilient, monolithic wearing surface, as contrasted with wood-block or brick pavement, or those that while monolithic are non-plastic.

The first extensive mileage of asphalt road was mainly of the so-called penetration type. In this type the stone is placed in the roadbed and the hot asphalt poured over it. The advantages of this method are cheapness, elimination of the need for expensive plant equipment and the possibility of using large stone—up to 2½ or 3 inches in diameter. The disadvantages arise out of the fact that the method permits careless workmanship, which is usually evidenced in insufficient coating of the stone. But with a natural asphalt binder, one that does not lose its cementing power and which is viscous at high temperatures, very durable highways can be and are being built by the penetration method. In proof of this may be instanced the Bermudez asphalt macadam highways built in New York and Massachusetts, in 1909 and 1910, which are still in service and which have cost little or nothing for maintenance. As only reasonable care and skill are required to secure good highways by the penetration method, it would evidently be an economically unsound proposition to abandon it simply for the reason that absence of care and skill result in poor roadways.

As the willingness to make, and the necessity for making larger initial investment in highways increased, mixed method roads came into greater favor. Such roads require a plant in which the asphalt binder, sand and stone can be combined hot before the mixture is laid on the foundation, which may be either old macadam, concrete or brick—in fact any adequate support for the wearing surface. In the form of asphaltic concrete such pavements at their best are standard sheet asphalt mixtures with the addition of fine stone chips. A noteworthy example of such a pavement is Riverside Drive, New York. An equally noteworthy example of mixtures in which stone predominates is the Trinidad asphalt macadam pavement laid on the Thames Embankment, London, in 1906.

COLLOIDAL CHEMISTRY STEPS IN.

The recent investigations of Clifford Richardson, who has specialized in asphalt chemistry for 25 years, has done much to place the formulation of asphalt paving mixutres on a rational basis. These investigations started some 18 months ago with the discovery of colloidal clay in Trinidad asphalt. Matter in this form does not settle out, nor can it be filtered out of solutions. It has exceptional adsorptive qualities, which in combination with bitumen results in the asphalt cement being held more tenaciously in a thicker film about the aggregate than is the case with asphalt which lacks colloidal content. Colloidal matter also results in affording an immense surface area to which the asphalt cement may adhere. This can be readily understood if it is considered when a cube 1 centimeter in diameter is reduced to particles of colloidal size, the surface area of the original cube is increased 100,000 times.

Heretofore no material finer than that passing a screen of 200 meshes to the inch has been considered in the formulation of paving mixtures. But as a result of Mr. Richardson's investigations we now enter the realm of matter approaching atomic size and made visible only by the aid of the ultra-microscope. It seems most probable that this will be the final blow to rule-of-thumb methods in the paving business; for while there has been great progress and improvement, it was not until Mr. Richardson's colloidal theory was developed and announced in 1915 that we could fully account for the performance of differ-

ent asphalts in different paving mixtures. The toughness and durability of pavements constructed with asphalts now known to contain colloidal matter has long been observed, but has not been before explained on grounds satisfactory to the chemist and engineer. With the knowledge of the action of colloidal matter as a starting point, it is now possible to proceed on rational lines in the formulation of mixtures and the selection of asphalt as a cementing medium therefor.

DIFFERENTIATION OF ASPHALTS.

To the layman and to many of those engaged in highway construction "asphalt" means almost anything that is black and sticky. There is, however, as much difference between asphalts as there is between wood and stone. The native asphalts formed by the slow processes of nature at normal temperatures form one important group of materials available for road building. The other group is composed of the residual or oil asphalts manufactured by boiling down petroleum to a semi-solid consistency, the process being completed in a few hours at very high temperatures. The raw materials of such manufacture, namely, crude petroleum, of course vary in origin and quality; so also do the methods used and the care employed in refining. Evidently there is here so great an opportunity for variation in results that sufficient reason is provided for the greatest care in the selection of bituminous material for road building.

The necessity for such care is increased rather than diminished from the fact that most asphalts analyze very much the same when they leave the refinery, and may therefore be deceptive as to their future performance. Ductility, for example, is one of the most important qualities in an asphalt. Practically all asphalts can be made to show ample ductility in the laboratory; but after combination with hot stone some of them show a great loss in this property. Evidently it is necessary not only that an asphalt should possess but that it should retain the properties of a paving cement. It is along the lines of such requirements, combined with good workmanship and the formulation of better specifications that the progress of asphaltic highway construction should go.

An important factor in this progress will be the adoption of the proper specifications. We now know how an asphaltic road-

way either of the mixed penetration type should be constructed, and the knowledge so gained should be represented in specifications for future work. For the reason that "a road is no better than its asphalt" it is especially important that that part of a specification referring to the asphalt cement should be so worded as to secure material precisely of the nature required. This cannot be accomplished by adopting wide-open specifications that admit materials of varying qualities and varying prices, for inevitably under such circumstances the more expensive and more desirable materials will be barred out if the lowest bid is accepted. On the other hand it is not usually considered desirable that closed specifications should be adopted. Fortunately a middle ground is provided by means of the so-called alternate specification describing separately the two principal classes of asphalt, namely the natural asphalts and the residual asphalts; and calling for separate bids on each. The community can then select the material that it thinks will give it the most service for the money expended. No monopoly is created by the alternate specification, nor is competition decreased. On the contrary it is increased, for we create the competition among various contractors for the various classes of material, and the figures for one type of paving invariably have considerable influence on the prices of the others.

The common sense of the alternate asphalt specification should, therefore, ultimately lead to its universal adoption. As a matter of fact it is being adopted in a great many communities and by highway departments. The course of improvement in this particular has usually been that of a reaction from a closed specification for asphalt to a wide-open specification, and then to one of alternate type, in which materials which are essentially different are separately described and separate bids taken thereon with full liberty of choice after the bids are in to select that which offers the best bargain to the community.

FIELD FOR HIGHWAY ENGINEERS

BY F. A. CHURCHILL

With the Dunn Wire-Cut-Lug Brick Co., Conneaut, Ohio.

Designing and constructing street pavements and highways has become a specialized branch of engineering. Road improvement as an adjunct to agricultural and commercial development is now so far recognized as a necessity that modern road building is limited only by ability to finance the movement. No settled section is now deaf to the appeals of reason and self interest. Yet great as has been the mileage of road improvement during the past decade, the surface of possibility has been no more than scratched.

There are, in the United States, approximately 2,200,000 miles of established highways, of which only 240,000 miles have been nominally improved. However, fair percentage of improved roads, so called, should be considered in the past tense. Cheap improvements in which the factor of durability was missing went bad long ago, and many roads still classified as improved have reverted to their original state of badness, or even worse.

After the good roads idea had found pretty general acceptance, but before the cumulative evidence of many sections of country had in some measure convinced the public that different types of roads had different values, the general tendency was to make quantity instead of quality the objective. The aim was to construct as many miles of road as was possible with the money available. Scientific study of actual and potential traffic conditions was unthought of. As a natural consequence, types of roads entailing the least initial cost were given preference.

The public is gradually learning the expensiveness of cheap construction, and as knowledge of the fundamental principles of durable construction extends, a vast field for highway engineering opens. Indeed, the demand for really competent, up-to-date highway engineers already exceeds the supply.

Our colleges and universities are seeking to fulfill their obligations to the public and to the young men of the country by offering courses in highway engineering. This is a laudable undertaking, and it is laying the ground work for a future

usefulness that will be of immense value. Some of these schools of highway engineering are in an experimental stage—tentative ventures the success of which is yet to be demonstrated. Other schools have taken up the problem seriously and with evident determination to succeed.

There is a difference of opinion regarding the practical value of the training given in some of these schools, but that is a matter which will work itself out in time. The gratifying fact is that our higher institutions of learning realize the need for trained highway engineers and are trying to fill the gap in educational opportunities.

It is, perhaps, inevitable, that theoretical highway engineering, taught by theoretical highway engineers, is preponderant in some of the schools. It is unquestionably true in many instances that graduates leave these schools with little practical knowledge of highway construction, although they are well grounded in the theory. The average new graduate can hardly be regarded as an expert, qualified to take entire charge of improvement work. Experience is needed. The same is true in any profession. Nor is it extensive work alone which is important. Every highway or street is important to the public, and anything less than the best engineering and construction is a wrong committed at the cost of the community paying for the service.

Young highway engineers need experience under capable chiefs. Young engineers acquire in the schools a knowledge of fundamental principles and they are taught the technique of designing; but the construction of a pavement involves matters of detail which the schools do not teach and which, in many instances, the schools cannot teach. In a vital sense, each pavement is a distinct problem. Local conditions of soil and topography and traffic modify general specifications and require the adaptation of methods to suit peculiar exigencies.

The highway engineer learns by experience that the success of his work often depends largely upon strict and correct attention to what appears to be minor details. It is only through the medium of experience that the highway engineer learns why apparently trivial details are of the highest importance.

That highway construction is rapidly becoming a test of engineering ability is a truth which ought to be emphasized. The

public is learning that an improved road which goes bad is not a good road. The public is becoming so far sophisticated in such matters as to be able to make a fairly just apportionment of blame between poor materials and constructional delinquences. The engineer in charge is justly blamed for the shortcomings of the contractor, since the latter is bound to follow the former's designs, specifications and orders.

In other words, as the engineer is responsible for the design and for the way in which the contract is executed, he is held to strict accountability for results.

Exceptions to this rule are noted in case higher authorities—either public officials or property owners, select a type of pavement which no degree of engineering skill can make durable.

A fundamental, and enormously expensive weakness in our system of road improvement is in allowing incompetent persons to determine the kind of roadway to be constructed. Only a competent engineer can estimate the volume, kind and weight of traffic that a highway may be called upon to bear in future years. Only a trained and well informed engineer knows what kind of road surfacing and constructional methods ought to be adopted in order to assure a roadway that will endure until long after the construction bonds shall have been paid.

The engineer should stand between the tax payers and their ignorance, prejudice, errors of judgment and penny-wise policies. Unfortunately the engineer can do no more than proffer advice. He cannot select the type of pavement to be constructed, although not even the best engineers can make a durable road with satisfactory surface if he is compelled to use unsuitable materials.

Nevertheless, the engineer who is loyal to his convictions and to the public is gradually coming into his own. The people are beginning to heed the advice of engineers who are known to be honest, fearless and capable. Costly experience with inferior types of roads is teaching the public to rely upon the judgment of unbiased experts.

In Europe, the engineer decides all highway questions. If a road is to be improved, the authorized engineer determines the kind and width of improvement, the grades, and where the road shall go. That is one reason why Europe has an intelligently designed system of good roads. Another reason is found in

the fact that contracting usually is an hereditary business descending from father to son generation succeeding generation. Contractors, therefore, have pride in their work and they are loyal to the traditions of their families. The third reason is that government supervision supervises.

The best highway engineers know that the final word in highwway construction has not been spoken. There remains something to be learned.

This fact gives an incentive to ambitious men to engage in highway engineering. The field for development is unlimited. During the past year remarkable progress has been made in brick highway engineering by the adoption of new methods of construction. Methods regarded a year ago as standard, and therefore the best, are being discarded as the superior merits of advanced methods become known. There has been within the twelve months last past greater progress in scientific brick pavement construction than there was for more than a decade previously, and greater progress toward perfection than has been the case with any other type of pavement.

The use of a cement-sand bed and of a mortar bed in lieu of the sand cushion has virtually revolutionized brick pavement construction. The change makes monolithic construction an accomplished fact, whereas formerly it was a theoretical assumption.

Formerly, all brick pavements constructed according to standard specifications consisted of three sections—a concrete foundation, a sand cushion and the brick surfacing. Because the brick were bonded together into a solid slab by means of a cement-grout filler, the pavement was called monolithic. It is obvious, however, that the term as applied to the entire pavement was a misnomer. There were in fact two monoliths—the concrete base and the brick surface, separated by 1½ inches of sand. The new form of construction gives a single solid beam surface to sub-base, the cement-sand bed or the mortar bed effecting a complete union between the brick surfacing and the concrete foundation.

In point of strength and durability the new type of brick pavement has a decided advantage over the sand-cushion type, and by obviating constructional hazards due to the effects of

bad weather on the sand cushion, the new type commends itself to the favor as well of contractors as of engineers.

The cement-sand bed, thoroughly mixed in proportions of 1 to 4 or 1 to 5, is spread dry over a set up concrete foundation and is rolled and compacted so that it has a depth of not to exceed 1 inch after being struck with a template to a true cross section corresponding to the surface of the finished pavement. After the brick have been placed, and before grouting, the wetting down of the brick converts the cement-sand bed into a mortar which, in setting up, binds the brick to the foundation.

In the green concrete, or rigid, type of construction the brick are laid directly upon a green concrete foundation, the inequalities of the surface of which are equalized by means of a film of cement and sand, mixed and applied dry in proportions of either 1 to 4 or 1 to 5 as the engineer prefers.

In this case the brick are rolled immediately with a hand roller weighing from 800 to 1,000 pounds, and the cement-grout filler is put in at once.

With this type of construction, the entire pavement is completed, so far as any work is done, at the end of each day's working period.

Pavements constructed in this manner do not require curbing or edging, or expansion joints. The pavement from top to bottom being a true monolith, the construction of shoulders or beams along the sides is all that is necessary.

It is, of course, indespensible that all the brick be thoroughly bonded to the bottom and at all points of the bonding joints. This can be done only if the joints are uniform and of sufficient width to permit free flow of the bonding material into all the interstitial spaces. It has been demonstrated that Wire-Cut Lug brick fulfill the requirements of this type of construction better than any other paving brick, as the lugs of this brick are uniform and the rough contract surface caused by Wire cutting without repressing, assures a perfect union between the filler and the brick. The square edges of Wire-Cut Lug brick give a flush joint at the wearing surface, so that the pavement remains smooth, even, sanitary and durable.

Another advantage possessed by brick pavements constructed after this manner is the elimination of rumbling and other noises sometimes noticeable in brick pavements built with sand

cushions. Traffic passes almost silently over the rigid type of brick pavement, and, on account of the solid bearing under the brick, if the pavement joins another type of pavement there is no tendency of the final course of brick spawling or breaking joint.

Both of the new types of construction are being adopted by cities and state hgihway departments. Baltimore now lays all its brick pavements on cement-sand beds, and miles of the Lincoln Highway and Dixie Highway will have similar construction. The state highway commission of Illinois is using the rigid construction on a number of state-aid highways, and highways in Ohio are being paved with brick in the same way.

Although the two new methods of construction have been in use only since the summer of 1915, already they seem destined to supplant old methods almost entirely.

These facts substantiate the statement that a wide field of endeavor is open for young men who are ambitious to succeed as highway engineers.

WINNING ZINC BLENDE.

BY H. B. PULSIFER

Assistant Professor of Metallurgy, Armour Institute of Technology.

The crude zinc ores of the United States are, in general, either extremely lean sphalerite-bearing rock or medium grade mixed-sulphide materials; the willemite ores of New Jersey and the carbonate ores of Utah, Colorado and Nevada are outside the scope of treatment which we are to outline as applied to the first and most important group of materials.

During 1914 this country produced over 360,000 tons of spelter worth over $100 a ton, an aggregate value of over $36,000,000; over 600,000 tons of blende were smelted, over 200,000 tons of the carbonate ores likewise went into the retorts. The carbonate ores received scarcely any previous treatment but this huge tonnage of the blende ores represents the material won from the low and mixed ores and brought to much higher grade than the carbonates before being charged into the retorts.

The crude ore of the Missouri zinc mines averages from 1.25% to 2.25% zinc; this rock is worked to make a product averaging 58% zinc. Practically all the mines have to separate galena from this high-grade sphalerite concentrate; some of the mines have to also get rid of considerable pyrites in the milling operations. The average recovery is not far from 65% and this Southwest Missouri region is the largest source of spelter which we have.

The Wisconsin zinc mines average about 3% zinc in the crude ore; wet concentration makes a product averaging 38% zinc, which latter can be increased to 60% zinc by magnetic separation. Total recovery in the Wisconsin field is no better than in Missouri. The Wisconsin ore contains not only galena but its wet concentrate is kept so low by the abundant pyrites which is eliminated by roasting and magnetic separation. This district produces about 10% of our spelter.

During 1914 the Butte & Superior mine of Montana from nearly 300,000 tons of crude ore running 18.6% zinc produced over 100,000 tons of concentrates containing 50% zinc. This

single mine, due to improved methods, has within a very few years taken the lead over all other mines and not only makes stupendous profits but produces a very considerable fraction of all the country's spelter. Its mill concentrates now average about 54% zinc while the mill recovery is around 92%.

Missouri zinc mills use jigs and reciprocating tables, exclusively for recovering and separating the concentrates; the Wisconsin district uses jigs, tables and magnetic separating machines for producing the 60% concentrates; Butte and Superior uses jigs, tables and flotation cells; a few western plants use electrostatic machines with or without previous treatment with jigs and tables. The five important finishing machines are, then, jigs, tables, magnetic-machines, flotation units and electrostatic machines. It is understood that an immense variety of crushing, grinding, sizing and classifying machinery is necessary to prepare the ores for the final treatments in the finishing machines.

It is the specific purpose of this exposition to bring to the attention of chemical engineers the problems and possibilities of these finishing machines in the separation and cleaning of zinc blende. Jigs depend on the stratification of minerals according to their specific gravities in a compound pulsating current of water; the ability of finer sizes of the heavy mineral to penetrate a dense *coarse* bed of the same mineral is a highly essential function of the operation. Tables expose the light and heavy minerals to a cross flow of water on a riffled deck which reciprocates at such a speed, stroke and intensity as to best clear the heavy mineral at the finishing end. Magnetic machines pick the magnetic particles out from a mixture of the properly sized and dried minerals, leaving the uninfluenced blende behind. Flotation cells generate a froth in a suspension of mixed minerals, after which the selectively chosen particles are cleared from the gangue by the rising and floating away of this froth; besides the obviously necessary areation and churning to make the froth it is accentuated by using acid and oil, one or both, to intensify the action. Electrostatic machiness depend on the electrostatic repulsion between properly sized and dried and highly charged particles and a similarly charged electrode; as the charged particles fall past the electrode, depending on their specific nature,

the particles fall close in or are repelled outward and drop in their own bins, respectively.

It is seen that the chemical and physical natures of the minerals are exploited to react with frictional surfaces, currents of water, magnetic fields, air bubbles and liquid films, and electrostatic fields to produce the required separations and cleanings. What industrial field comes better within the scope of the chemical engineer! Here are processes under rigid chemical control; processes calling into play his widest and most detailed knowledge of the composition and properties of materials, the efficient and expert handling of solids, liquids and gases; here the theory and practice of sampling meet; here meets kinetic theory and capillarity; here one finds mineralogy, colloid chemistry and permeabilities hobnobbing with ions, specific gravities and conductors in a really intimate and practical, worth-while way!

The chemical engineer might almost step in and monopolize the field should he care to. The men of the works have not had his advantages and are slow to meet the exigencies; they are getting results but the results are never really flattering. Equipment is always failing, costs are high, recovery too often poor. The author recently had occasion to listen to the talks presented at the operators club in the chief blende producing section of the world: a speech by a health officer, an insurance adjustor, a lawyer and a local minister and the club felt oppressed by the seriousness profundity of the topics. How would such an operators' meeting react after an exposition of frictional coefficients, ether waves, dispersoids or surface tension! In this premier camp of the world for high-grade blende the fine Carnegie Library did not have a single book on or related to the subject of Ore Dressing! If our chemical engineer should possess ordinary sense, tact and manners he might have a runaway field in such a locality.

Let us now examine in slightly more detail typical instances of the cardinal machines for producing the clean blende.

THE COOLEY JIG.

This machine is that type of jig almost universally used in the Missouri and Wisconsin zinc fields. It is a large machine, requires considerable horse-power, handles up to 40 tons feed per hours, requires constant attention but is capable of producing

very acceptable product. In Missouri three jigs to a plant unit are common—rougher jig (for the crude rock), cleaner jig (for the enriched product of the rougher jig) and sand jig (for retreating the finer intermediates). In the Wisconsin field it is more common to find one jig doing all the concentrating and cleaning (see Fig. 1.).

Fig. 1

The machine consists of a series of flat cells, stepped one below the other, whose perforated bottoms allow the water, raised and lowered by the plunger in the back compartment, to alternately lift and suck on the bed of mineral which flows down from one cell to the other. As the cells are made to pulsate in sequence the mixed ore in flowing along the cells is stratified, the coarse collects on the beds and is periodically drained at the side; the fine heavy mineral settles through the bed, through the

perforations, and collects as clean concentrate in the compartment *under* the cells from which it is drawn off as desired. The pulsations range from 80 to 250 a minute with strokes from a half inch to one and a half inches, all depending on the size and purpose of the specific purpose. The fall from cell to cell, the main water flow at the head, the water per cell forced up through the grate, the thickness of the beds and the lightness of the beds are matters of precise control.

The beds must be kept free from packings undue accumulations on the grates; they must be drawn frequently but not robbed so as to let the light minerals through; they must have the middling layer constantly and uniformly drawn lest tailing losses mount. A good jig man is as valuable as the mill, itself; he is rarely found. He seldom has even high school education, and, besides being hopelessly arbitrary, usually has ingrained fallacies which render him a creature to be feared, studied and soothed. The greenest technical graduate is to be preferred to the wisest lived-all-his-life-on-the-job jig man! An open-minded lad can be taught to jig, but an old-time jig man can break a rich mine.

There are Faust jigs, Richards jigs, Hancock jigs, Jarvis jigs, New Century jigs, Bull jigs, Plumb jigs, and other jigs; but a good mine, a good mill and a good jig man are more essential, for the best jig in the world can be built on the spot in 48 hours!

THE RECIPROCATING TABLE.

The jig finds its normal place handling particles from 1 centi meter to 1 millimeter in size; for particles less than 2 millimeters in size some make of reciprocating table is preferred to any type of jig. In the Wisconsin district they have not yet seen fit to use any sort of table in most mills—all the work is done with jigs; but, in the Missouri mills and in practically every western mill concentrating *tables* are a vital part of the plant.

The reciprocating table is a complicated machine and demands high attainments from its manager. It is likewise a remarkable servant and can accomplish an astounding amount of beautiful separating and cleaning.

We have already mentioned that the jolting back and forth of the deck can be adjusted as to the number of jolts per minute, the full length of the jolt, and the relative speed at start or

finish of each individual jolt. Other adjustable features are found in the substance which covers the deck (this comes in frictional contact with the particles); the number, width, depth and length of the riffles on the surface of the deck cover; the forward slope of the deck, the side tipping of the deck; and, finally, the amount and distribution of the pulp to be concentrated, and the amount and distribution of the wash water.

A table thus has not less than *fourteen* independent variables, the best relations and adjustments of which must be brought into play. More than this, the table must be kept in this state of best adjustment: variations in feed must be attended to while the mechanical and structural integrity of the apparatus dare not digress. If the linoleum swell and lift at some point, or, if a little vertical quiver develop at one corner, the mechanism begins to do its work badly.

In Missouri the "sludge monkey" is a reasonably paid man whose chief function is to watch the tailing spout and be on hand when the mill breaks down. He does not comprehend the difference between sizing and classification; he is silly on the matter of recovery; he runs the table just the same even if it develops a vertical motion to exceed the horizontal! Happy to relate they are now in Missouri (since the high price for ore came) beginning to look on the sand end of the mill as worth noticing.

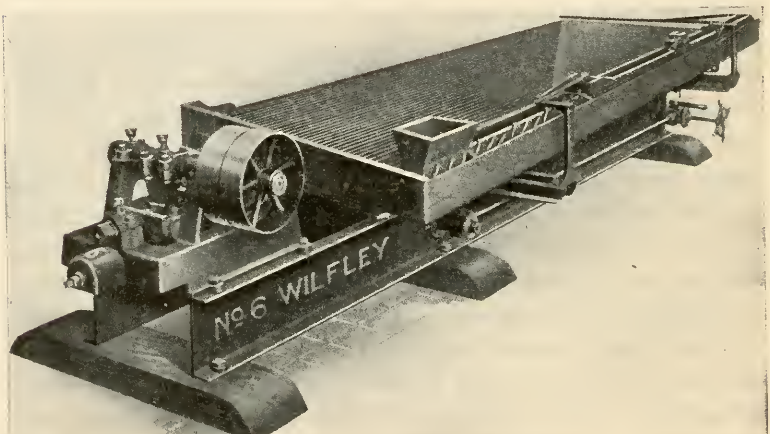
You say that concentrating tables are made by reputable firms, and installed, and started operating in perfect fashion, needing only to be kept in this established condition for permanent and maximum results. It is fortunate that reputable firms do make and establish a fair standard for their machines. But firms are primarily in the business of *selling* tables and under competition and by no means uninfluenced by foolproofing, average usefulness. Then, again, even the highest priced machines vary widely in many essential respects. Is progress in table evolution at a standstill? Who shall design the tables for the manufacturers? With tables operating for some decades by the thousand, all having straight riffles, we are suddenly informed that a curved ending gives superior results!

Our illustration No. 2 shows a Wilfley table; the base, head-motion, deck, diagonal ending riffles, feed trough, water box and tipping adjustment are all in evidence. This is one of the

very best tables made. But it is for prescribed work; it can be easily exceeded for coarse roughing work, for clean triplex separations at the head, for treating less than 100 mesh material.

There are many such tables, all excellent ones, but the work in hand demands infinitely more than selecting and using some good make of table. It requires critical analysis and fittng adaption to the specific needs of the case. The "sludge monkey" befits his name on the job; the trained engineer finds a case worthy his professional study!

In the West we find these makes of tables widely used: Wilfley, Deister, Overstrom, James, Card, New Standard; other designs of real merit are less widely known. In the Missouri district the local crop of tables is largely made by Ford, Lycans & Stillwell, Perry, United Iron Works, Kirk and Arbuthnot; a good sprinkling of tables from the first mentioned list is also found in the plants.



MAGNETIC SEPARATION.

This method of winning a clean zinc blende might more properly be called "roasting and magnetic separation" for it is at present carried out only on a concentrate containing pyrites; the pyrites being first changed to pyrrhotite or coated with magneic oxide.

The method is extensively used in the Wisconsin field; it is indeed characteristic of that section for by its use the zinc con-

centrates of the district, averaging 38% zinc, are brought to 60%. Some western plants employ the method although it is of far more restricted use than either jigs or tables. Wisconsin concentrates do not trend toward the finer sizes which are lost in the jigging; the roasting and magnetic machines likewise work best on the coarser sizes as produced by the jigs; the general practice thus fits together fairly well.

The entire process is much simpler and mare easy of regulation than the other methods mentioned in this discussion. The mixed blende and pyrites from the wet concentration is given a quick, light roast in a revolving cylinder; after discharging and cooling the material is transferred to the magnetic separating machines and run through. The distinctly magnetic irony particles are picked up by the influence of the magnets and swept to one side away from the uninfluenced blende. Several passes are easily given with return of middlings to roast again and retreat.

Obviously the original particles must be sensibly free pyrite or marcasite and free blende; the method breaks down just in so far as the sphalerite crystal contains iron or the first physical separation fails to separate blende and pyrite. Again, the more uniform the size of the particles the better the results; one cannot expect to produce the same chemical change on 2 millimeter and .2 millimeter particles. Although the oxidizing influence might make pyrrhotite in one case and magnetite in the other, dust is not desired. There is, in fact, slight tendency toward recovering finer particles in Wisconsin practice, for this very reason. The introduction of tables would increase the saving of the finer particles which would merely require removal and segregation at some later stages of the roasting and magnetizing departments.

In the Wisconsin district the magnetic machines are of the types known as Wetherill, Cleveland-Knowles, Dings and Campbell. The Wetherill was the original machine and is by far the most satisfactory; the other types have sprung up to avoid the patents and work to good advantage. They do not, however, improve on the Wetherill. Fig. 3 indicates the plan of the Wetherill machine; the main feed comes in on the endless belt and as the stream passes under the magnets the magnetic particles are pulled up into contact with the cross bolts which whisk

them rapidly to one side and into the proper receptacles, the clean blende being carried straight along into its own bin. The Cleveland-Knowles machine consists of an electromagnet revolving above a conveyor belt, segments being made attracting and then inactive at certain points of the rotation. The Dings machine has the ore fed under the secondary magnets upon an inclined shaking table; the Campbell machine has the shaking table feeding the ore under magnets provided with cross belts.

Many Missouri concentrates could undoubtedly be improved by this sort of a treatment, nothing of the sort is, however, done in that part of the country. Adequate study by chemical engineers would quite likely improve Wisconsin practice and lead to wider adoption in the West.

We come now to a process which makes quite satisfactory separations and does *not* fail on the finer sizes.

FLOTATION.

Flotation is the most recent of the methods for producing a clean blende. It is not yet used in either the Missouri or Wisconsin zinc mills. It is the improvement which has put Butte and Superior on its feet, enabling it to become the largest and most important zinc mine in the country, at the present time earning upwards of $1,000,000 a month.

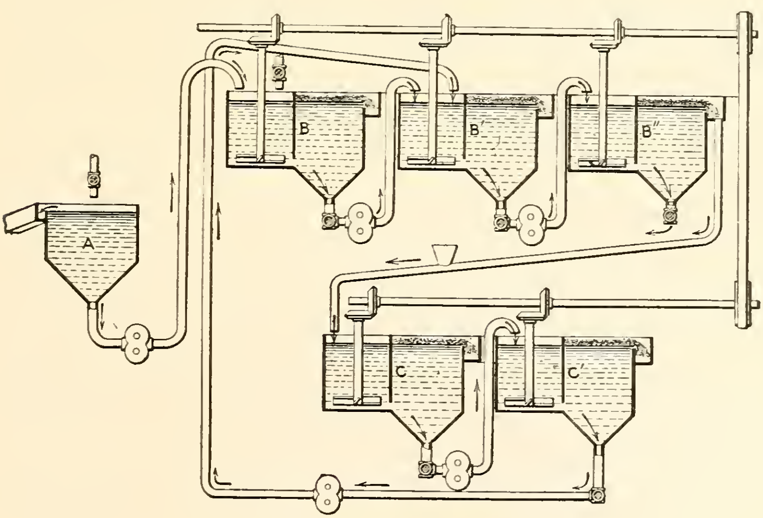
A highly interesting phase of the flotation industry is the effort of The Minerals Separation, Ltd., to control every adaptation of this entire method. It may be true that certain specific technique made the process a complete success in other countries and that it was introduced here in the improved shape with full satisfaction; on the other hand the process had so much experimental work done by various individuals, previously, in this country and is of such a broad scope with innumerable modifications that one may well doubt if the astounding effort to control every flotation operation, through the courts, will be successful.

For the full recovery of a sulphide from a finely ground rock the process works ot perfection and finds its chief application. Plants desiring to recover copper minerals from lean ore and plants in need of recovering the last fraction of galena from a lean ore have adopted the process with immediate satisfaction; thus for the porphyry copper mines and the disseminated lead

mines the process is now indispensable. The zinc mines are under the necessity of producing a high-grade concentrate and clean of other minerals; their problem is not so easy, but the following are using some sort of flotation process: (plants making zinc blende concentrate)

Federal Mining & Smelting Co., Morning Star Mine....Idaho
Green Hill-Cleveland Mining Co. ....Idaho
Hercules Mining Co., Hercules Mine ....Idaho
Interstate-Callahan ....Idaho
Gold Hunter Mining Co. ....Idaho
Butte & Superior ....Montana
Timber Butte Mining Co., Elm Orlu Mine...........Montana
M. W. Atwater, Basin Red. Wks. Tails.............Montana
American Z. L. & S. Co., Mascot Mine.............Tennessee
Ozark S. & M. Co., Graphic Mine..............New Mexico

At these mines listed well over a million tons a year of crude ore have a greater or less percentage of their substance treated by the flotation process.



Flotation Diagram

Why do the sulphide minerals float and the earthy minerals sink in flotation processes? There is very extensive literature on the subject; the particular lack at the present moment is that

those who work and write with the process are not conversant with molecular physics. Likewise, those who are most adept with the theoretical exposition of surface tension, oil films and froths do not grace the technical literature with their scientific mathematics.

With full liberty for future interpretation the facts are that by violent agitation, or areation, or even quiet slidings; in acid, neutral or alkaline solutions, and commonly with the aid of oil, the sulphide particles can be separated from the gangue. Temperature may have a remarkable effect; the sort of oil may have remarkable specific influence; some additive chemical in very small amounts may solve the whole trouble.

One sees that while results may be obtained without trouble in one case the solution of another instance involving slightly different mineral, gangue or separation may require extensive and intelligent research. In other words, it is a worthy field for the chemical engineer. Reflecting for a moment on the excessive wastes of many present operations (Missouri and Wisconsin) and then on the uncounted millions to be won from the great mixed sulphide deposits (throughout the entire Cordilleran system) it is a fair chance that the stakes are high enough and the field open.

ELECTROSTATIC SEPARATION.

In practice this method becomes applicable only to the separation of blende from pyrites or marcasite. The preliminary concentration is best done by wet methods. The process must be carried out on bone dry particles; dust works badly by the process. Unless the operations are done in rooms unaffected by the humidity changes of the weather results are erratic.

This is the least important of all the separating methods; only some six mills, and those in the western states, are using the process; the tonnage treated is not likely over 100 tons of enriched material a day.

	Tons, 24h.
U. S. S. R. & M. Co., Midvale, Utah	50
Sunnyside Mines, Eureka, Colo	20
Mary Murphy Mine, St. Elmo, Colo	15
David Forrester, Ouray, Colo	20
Calumet & Sonora (Not in Use) Cananeag, Mexico	50

For special conditions the process may be highly useful; the generation and application of the high potential electricity (over 20,000 volts) is being improved upon; the drying, sizing and separating processes are in evolution. But the fact that the material must be absolutely dry, that the finer sizes are discarded, and the fact that the process cannot be applied to crude ores makes a combination of obstacles to general usefulness presaging no general expansion. We note that this is exactly opposite the case with flotation.

RESUME.

In the winning of blende we find an enormous industry and an assured future. The raw materials are of extremely wide occurrence and with values possibly greatly enhanced by accompanying minerals and precious metals.

The zinc smelting industry does now and bids fair to, in the future, demand blende as high as possible in zinc content. Below 60% zinc content the value of the ore falls off, slightly at first, but then rapidly, so that below 45% zinc ores may be quite unmarketable at any price.

The raw zinc ores occur in every degree of blende purity and mineral complexity. A free-milling Tennessee rock may mill out directly a 64% zinc concentrate; a Wisconsin rock may mill wet, and magnetic separate, dry, to a 60% concentrate; a Montana rock may concentrate, with separations, to a 56% concentrate. From such results for the successful work the illustrations for poor showngs and difficult work increase just in so far as one studies the subject.

The technically trained man finds in attacking these problems that all his resources and talent will come into play. Proficiency in mechanical engineering and millwrighting is one foundation stone; proficiency in mineralogy and hydraulics is another stone; proficiency in electrical engineering and chemicl engineering is indispensable; a thorough knowledge in mathematics and especially the more subtle mechanical and physical and chemical molecular phenomena is really at the base of the operations, whose understanding and application will make intelligent progress in the art.

We do have some very high grade engineers in the field; it is their systematic effort which has accomplished the greater

results. Looking over th country, as a unit, it is the opportunity which stares back from mountain, mine and mill. Untrained and inefficient men labor at great odds with poor results; deposit after deposit awaits the advent of new effort while stream after stream of crude rock calls for improved treatment and many a tailing pile awaits the master mind. „

For the great service of a trained men lies not so much in his fund of information, which anybody can obtain, as in his ability to critically analyze and systematically experiment; the first makes clear the trouble, the second demonstrates the improvement. A liberal and a technical education is the prime requisite for such constructive attitude; the first compliments a man for questioning the truth, the second inspires him to patiently fit together until a new and better result is accomplished.

PART 2—THE MANUFACTURE OF SULPHITE CELLULOSE BY THE RITTER KELLNER PROCESS

BY C. C. HERITAGE

Chief Chemist, Nehassa Edward Paper Co., Port Edwards, Wis.

In his first article Mr. Heritage reviewed briefly the entire process of cellulose manufacture. In this second article the storage of the wood and the operation of the wood room is carefully considered. In the concluding article the most important units to the chemical engineer will be discussed, namely, the acid plant and the digestion proper.—The Editors.

Wood storage. Upon the receiving of the logs their condition should be carefully noted. Hemlock pulpwood may vary in diameter on 16 foot stuff from 6 inches to 60 inches and often times smaller than this on shorter logs. It is hard to say just what size is preferable and this may be said to depend somewhat on the unit of measurement used in buying. If the cord is used then the larger the diameter the more solid wood is purchased per cord. However, the large interstices may be filled with smaller logs so that mixed logs will probably show a still larger cubic contents per cord. If the pulp wood be purchased per thousand feet board measure as is likely to be the case with large logs, medium diameter of ten to twelve inches is most desirable in as much as the slabs and edgings are a larger per cent. of the total cubic contents in this case than with large diameter logs. The whole proposition of purchasing pulpwood by cord or board measure is unscientific, though perhaps the difficulties encountered in measuring moisture content if a weight basis were used would make the matter just as unsatisfactory. The medium diameter log is also desirable in that the sap or younger fibres are stronger and more flexible than the old heart wood.

A careful supervision of the lumbering operations by a mill representative, preferably a trained forester, should always obtain. Rotten timber should be refused even before getting to the cars and all precautions should be maintained to keep the logs after being cut from being needlessly dragged about the ground for a coating of dirt adhering to a peeled log can introduce more specks into a finished pulp than all the care in handling subsequent to delivery at the mill can eliminate.

When the demand for hemlock bark is sufficient and time and labor available the logs are peeled at the logging camp and the bark used for tanning purposes. At other times the logs are

shipped just as felled. This practice makes a barking equipment necessary of sufficient size to handle the entire input, which equipment lies idle during the consumption of peeled wood. Peeled wood is greatly desired aside from the above consideration inasmuch as it seasons more rapidly and is less susceptible to decay.

Plate II gives an excellent view of a wood storage yard in which the logs are allowed to season for as long a time as possible to come to low moisture content. The seasoning also

Plate II

has a bearing on the elimination of pitch troubles. The logs arrive on flat cars and are handled either by a jammer—a specially constructed derrick, or by a cableway. The towers of the cableway may be noted in Plate II. The jammer method is considerably cheaper per cord.

After as much seasoning as possible—from one to two years —the logs are reloaded, switched to the woodroom, and transferred by hand to the Bull Chain, the conveyer entering the wood room. Plate III shows this step in the process. The Bull Chain loaded with logs appears in the foreground of the picture.

Figure 2 is an ideal diagram of the wood room. Every log passing the scaling deck is measured for board feet and the quantity of rot estimated. A rough separation of large and small logs is generally effected at this point. All logs under

Plate III

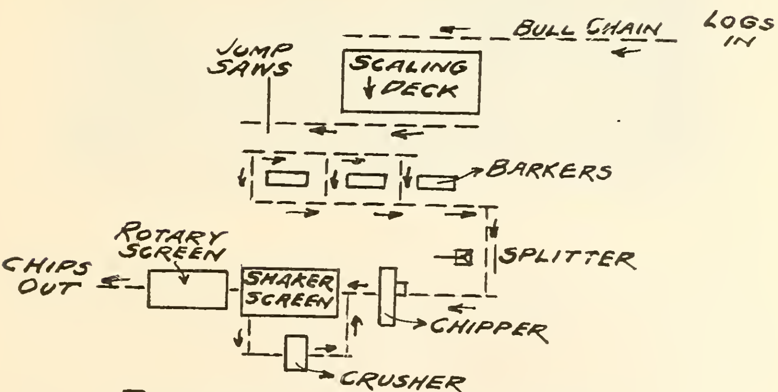


DIAGRAM OF WOOD ROOM

-- CONVEYORS

→ COURSE OF WOOD

C.C.H
11/2/15

FIG. 2

nine inches diameter are passed on to the slasher saws, not shown in the diagram, and are sawed in two first, and the eight foot lengths then sawed to two foot lengths at one operation by three saws set staggered on the saw deck. This procedure is not feasible with larger logs because of the size of saws necessary. Hence the logs over nine inches are passed to the jump saws as shown in the diagram. These are two in number and are set one above the other, each being capable of movement vertically. The log passes to its position and is held there while half the cut is made from below and half from above.

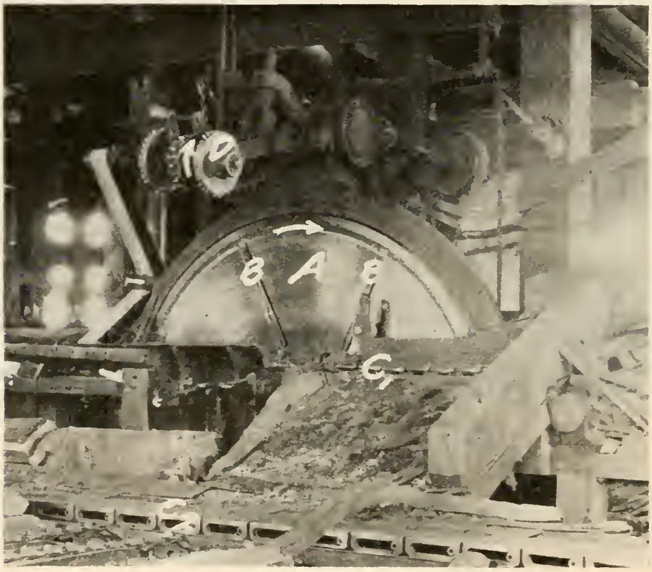


Plate IV

The two foot lengths if not peeled pass to the barkers. The larger wood is treated on so-called steam barkers as shown in Plate IV, while the smaller wood which has passed the slasher saws is barked on smaller hand barkers.

A barker consists of a circular disc of steel mounted vertically on bearings, turning over at about 600 R.P.M. and fitted with a number of knives radiating from the center and bolted to the disc in such a manner that the blade of the knife projects from 1/16 to 1/8 of an inch. Referring to Plate IV "A"

is the steel disc; "B, B" are two of the seven knives on this particular machine; "C_2" is the conveyor leading to the splitter; C_1 is an arm or head which drops against the stick of wood holding it against the face of the disc, but at the same time allowing it to turn in the direction indicated but considerably more slowly than the corresponding peripheral speed of the disc. The bark is quickly removed and also considerable wood. In fact this old design of barker just described is a very inefficient, wasteful machine causing a loss of from 15% to 25%. The awful significance of this loss is apparent when it is considered that the wood cost of a ton of sulphite amounts to at least 50% of the total cost.

On account of this great waste several new processes for barking have been worked out in late years, which are worthy of brief mention. The first is an adaption of the ballmill idea except that the sticks of wood themselves do the work of the pebbles in the ballmill. A typical installation for small diameter stuff consists of a heavy steel cylinder about seven feet in diameter by nine feet long rotating at 12 R.P.M. about the axis of the cylinder. The capacity of such a drum is about 2½ cords and the charge is completely barked in from 1½ to 2½ hours depending on the actual size of the sticks. Water is introduced through one trunion and bark and water discharged through the opposite one. This refuse is very hard to handle as fuel and must be pressed hydraulically before combustion is attempted. This system is seen to be intermittent. The big drawback, however, lies in the fact that small pieces of bark and dirt are driven in the splintered ends of the pieces and find their way ultimately into the pulp.

A new continuous barking drum which has very recently been put in the market is built of heavy angles and channels riveted to annular angles. A perforated drum with rough interior is thus obtained. Both ends of the drum are open and half filled with wood and submerged in a tank of water. The bark is removed by the tumbling action of the blocks as in the first drum described but the pieces tend to remain parallel throughout the length of the drum. The time necessary for passage through the drum is variable depending on the speed of feeding the sticks as the drum is mounted on the level. The bark is removed from the vat outside the drum by paddles riveted upon

the exterior of the drum itself and must be pressed before combustion. These drums are about 20 feet long by 10 feet in diameter and will handle 30 cords dry wood per ten hour shift or twice that amount on wet wood.

The two foot barked sticks are now conveyed to the splitters, two types of which are shown in Plates VI and VII. The former is the hand operated vertical type, in which the block is placed by hand between the Block "A" and the splitter head "B" which takes a reciprocating vertical motion through the crank "C." The latter horizontal type handling large wood is shown in Figure VI where "A" is reciprocating splitter head driven by the crank "D." The block travels in on conveyor and held against the rest "B" while the splitter head does its work.

The pieces of wood are now sorted and all poorly barked or rotten pieces are separated to be chipped together and cooked together to produce an inferior grade of pulp. The sound, clean pieces are conveyed to the chipper which is quite similar in design to a barker in that very heavy knives are mounted upon a heavy disc somewhat similar to a solid fly wheel so that the inertia obtained may be large. The knives are three in number and are set radially about half way out from center to edge. The whole machine is heavily housed to collect the chips, which otherwise would fly in every direction. The speed is about 220 R.P.M. The wood is introduced downward through a trough at an angle of about 45 degrees so that the chipping takes place downward and across the grain and the sticks feed themselves in by gravity.

It is very essential to have the chips uniform in size since large chips will not be wholly disintegrated at the end of the cook and in small ones the cellulose itself will be attacked and weak broken fibres result. The chips therefore aer graded by passing over two shaker screens, one placed above the other, which are simply shallow boxes about eight inches deep by 6 feet wide, by fifteen feet long. The bottom of the top screen has perforations of an oval shape of one inch by two inches and the bottom screen has round holes of three-sixteenth inch diameter. The sawdust adhering to the chips which pass through the top screen, but are retained on the bottom one, is further removed in a rotary screen of eight mesh about six feet in

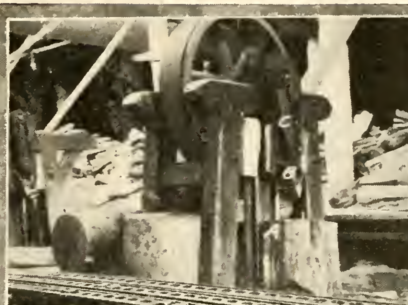


PLATE VI.

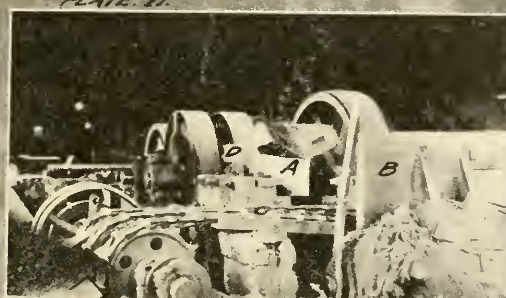


PLATE VII.

PLATE VIII.

diameter where the material is subjected to a whirling tumbling action. All screens are inclined at an angle of about ten degrees so that the chips work down gradually to the low end. The shakes per minute for the flat screens are two hundred, while the rotary screen turns over at fourteen R.P.M. The coarse chips collected on the top shaker screen are returned to a crusher which reduces the size and returns them to the top shaker screen again. All material passing the lower shaker and the rotary is passed to the boiler house.

The chips are now conveyed by endless belt shown in Plate VIII to the storage bins above the digesters. This belt runs at about four hundred feet per minute and discharges the chips by the ordinary discharging device used on all conveyors.

Chip tests are made on this material going to the bins by passing the chips through standard mesh sieves. Two analysis are given below to show how these results may be interpretated.

Fraction	Size	Per Cent. No. 1	Per Cent. No. 2
1	Over ¾″ Square	18.38	21.63
2	½″ to ¾″ Square	74.77	54.50
3	¼″ to ½″ Square	5.08	12.33
4	Thru ¼″ Square	1.77	11.53
		100.00	99.99

Fraction one is very coarse, two is good material, three is irregular and four is sawdust. Test No. 1, although showing an abnormal amount of coarse stuff is nevertheless a very good test while No. 2 is very poor for fractions one and four are large and three is small. The season of the year affects the size of chips as frozen wood is much more friable than dry material.

GOVERNMENT RIGHTS OF WAY FOR IRRIGATION

Address to Oregon Irrigation Congress, December 28, 1915

BY LEONARD LUNDGREN, C. E., M. S.
District Engineer, U. S. Forest Service.

I am especially glad to be able to say a few words at a meeting of this character on account of the intimate relations as prescribed by law between the National Forests and all uses of water, particularly irrigation.

When the National Forests were first created Congress defined as one of the three main purposes of Government control of the high mountainous forest regions, that of watershed protection in the interests of the people. Until about twenty-five years ago the forests on the public domain seemed in a fair way to be destroyed eventually by fire and reckless cutting. Nothing whatever was being done to protect them or even to use them in the right way. They were simply left to burn or else to pass by means of one or another of the land laws into the hands of private owners, whose interest in most cases impelled them to take from the land what they could get most easily and move on.

Had this destruction gone on unchecked there would in the end have been little timber left in the West either to burn or to cut, and the development of the country, which calls for timber not only at certain times but at all times, would have been retarded or stopped altogether. More than this, the destruction of the forest cover on the watersheds supplying thousands of streams which rise in the Western mountains would have had certain effects on stream flow—low water or no water at all during the long dry periods and destructive floods after heavy rains. This, of course, would have meant disaster to numerous systems of irrigation by which hundreds of thousands of farmers raise their crops. It would also have had a very serious effect on electric power development.

So in 1891 Congress authorized the President to set aside timber reserves, as the National Forests were then called, in order to protect the remaining timber on the public domain

from destruction and to insure a regular flow of water in the streams. The first, the "Yellowstone Park Timber Land Reserve," was created by President Harrison that same year, and later Presidents have created others until at present the total net area is approximately 157 million acres. Within the Forest boundaries are also some 21 million acres in private ownership, consisting of lands granted or taken up for one purpose or another before the Forests were created, or of homestead entries made since.

Congress made it the duty of Secretary of the Interior to prescribe regulations which would insure the fulfillment of the objects aimed at in creating the reserves. Timber cutting must not destroy the forests but must provide for the growing or a new timber crop. Grazing had grossly abused the range; it was necessary to devise methods for increasing the forage crop. Both timber use and grazing use must be so managed that water supplies would be maintained and bettered. All the resources of the Forests needed to be given careful consideration and plans devised for their best development. Without such plans little of the value of the Forest to the public could be secured. Technical problems were involved which the officials of the Interior Department felt to be outside of their province. They therefore at first requested the aid of the experts of the Department of Agriculture as advisers, and soon recommended the transfer of administration of the reserves to the latter Department.

This transfer took place in 1905. The following year the name "Forest Reserves" was changed to "National Forests" to indicate that their resources were not locked up as reserves for future use. In administering the National Forests the first aim of the Forest Service has been to protect their resources so that they will always be there to use and at the same time to see to it that the greatest number of people had an equal chance to use them.

Thus in a space of less than twenty-five years th Forests on the public domain have passed from a condition in which the timber was always in imminent danger of being destroyed to one in which it is everywhere being protected—from a state in which, as a result of repeated fires and wasteful lumbering

the annual growth was steadily decreasing, to one in which scientific management insures a steady increase in annual growth and a good supply of timber to the people for an indefinite period. Hunting, fishing and camping are unrestricted in the National Forests. Compliance, however, with state laws is required. Construction work of all kinds may be executed under the various laws by Congress.

The policy under which the National Forests are administered is to make them of the most use to the most people, but especially to the small man and the local settler. They are meant first of all to enable the people of the West to build and to maintain homes. In administering the National Forests it is planned that all land is to be devoted to its most productive use for the prominent good of the whole people and not for the temporary benefit of individuals or companies. All the resources within the National Forests, water, wood and forage, are for use and are conserved for the benefit of the homesteader first of all, upon whom depends the best permanent use of lands and resources.

Land more valuable for agriculture than for timber growing is excluded from the National Forests so far as is possible. Final adjustment of boundaries is now being made and will be completed in the near future. Small tracts of land which cannot be thus excluded are open to settlement under the Forest Homestead Act of June 11, 1906. The proportion of land within the Forests more valuable for agriculture than for growing timber or other purposes is trifling. Practically all such land has already been taken up, and therefore the chances offered prospective settlers outside of the National Forest boundaries are better than within. The Forest Service encourages bona fide settlement on the National Forests because the settlers help to fight fire and assist the Forest officers in many ways.

Oregon has a total area of 61,887,000 acres, 13,260,000 being National Forest land, of which 2,500,000 acres are mountainous and barren. Since the Forest Homestead Act of June 11, 1906, was passed 121,300 acres have been homesteaded in Oregon. There are over 1,000 special use permits and easements now in effect in Oregon covering an area of more than 106,000 acres and a length of right of way of more than 1,400

miles. Of the 2,900 billion board feet of standing commercial timber in the United States 546 billion or one-fifth is in Oregon. One-fourth of this or 136 billion is on the National Forests.

It must be understood that public lands cannot be legally occupied until express authority for this purpose has been issued by the proper department of the government. Many people erroneously believe that the mere filing of an application gives this right.

Congress through the Acts of March 3, 1891 (26 Stat., 1095) as amended by the Act of May 11, 1898 (30 Stat., 404) has provided means whereby easements across public lands and National Forests for irrigation reservoirs and canals may be secured. Complete information regarding the securing of rights of way under these acts may be obtained in the pamphlet issued by the Department of the Interior and available to the public through the various local land offices. It should be understood that easements can only be secured on surveyed public land.

The Government must determine before granting a right of way whether or not the applicant has the legal right to receive such a grant. It must also determine if the applicant has initiated a right to secure the water to utilize the right of way applied for and whether the proper technical studies for this purpose have been made. Field notes and maps are required so that the rights of way granted may be adequately protected by platting on the proper government maps. This explanation is made so that the demand for filing of various papers with the application may be understood. The uninitiated frequently complain of what appear to them as excessive requirements.

Applications for irrigation easements must be filed at the local land office of the district in which the project is located. The application is then forwarded to the Commissioner of the General Land Office, Washington, D. C., who causes investigation to be made by the various branches of the government such as Geological Survey, Forest Service and Reclamation Service, to determine if the welfare of the public will best be served by the grant of the easement or the rejection of the application. The thoroughness of such investigation varies with the importance of the project, becoming exceedingly rigid when various public interests appear to conflict. Sometimes this entails the

examination of the financial ability of the applicant to complete the project, and of the engineering plans. These reports are returned by the men in the field to their respective bureaus in Washington, who in turn make appropriate recommendations to the Commissioner of the General Land Office. The Commissioner then forwards the grant of the easement or the rejection of the application to the applicant through the local land office.

Congress has also provided through the Act of June 4, 1897, a means whereby legal authority may be issued by the Forest Service to occupy and use National Forest land either surveyed or unsurveyed. Revocable permits may be secured more quickly than easements under the Act of 1891 as amended by the Act of 1898, as the requirements and the procedure are less complicated and the permit is issued by local authorities. An application must be filed with the Forest Service for a permit under the Act of June 4, 1897, or the Act of February 15, 1901, if any unsurveyed National Forest land is to be occupied, as Congress has provided no means for the granting of an easement in this case.

When a project occupies surveyed public land and unsurveyed National Forest land and an easement is desired, applications should be filed with the local land office and the local office of the Forest Service. If a grant and permit are then issued the grantee will have prior right for a permit on the right of way covered by permit when the public land survey is extended over the unsurveyed land under the project. Action may be greatly expedited if applicants appreciate the necessary routine and co-operate with the field officers of the government. I am glad to say this is heartily given by practically all irrigators who mean business.

Further details on this subject will be cheerfully given at any office of the U. S. Forest Service.

COAL COSTS IN BOILER PLANTS

BY G. A. GRASSBY, JR.

Mechanical Engineer, with the Link Belt Company, Chicago.

In attempting to interest prospective purchasers of automatic stokers the most important question which the salesman must answer is, "How much money can I save in a year with your stoker?" To answer this the seller must have some comparative data on the existing plant as well as on the proposed installation. With this in hand he would require steam tables and other information, from which he could calculate the relative costs of coal per year for a given plant. This requires some time, and quick action is necessary if the buyer's interest is to be held. In order to put this information into simple and usable form the accompanying curve sheet has been devised.

A short review of the steps taken in preparing this data will indicate the method used. Given the efficiency and the heat value of the fuel we may determine the number of pounds of coal required per boiler horse-power per hour. With the pounds of coal per B. H. P. hour and with the cost of the coal we may find the cost of the coal required per B. H. P. hr. Then, from the cost of coal per B. H. P. hr. and the number of hours per year the boiler is in operation we may calculate the cost of coal per B. H. P. per year, which is the required result. In order to make the curves usable from a commercial standpoint the units have been increased to read "Cost of coal per 100 H. P. per year."

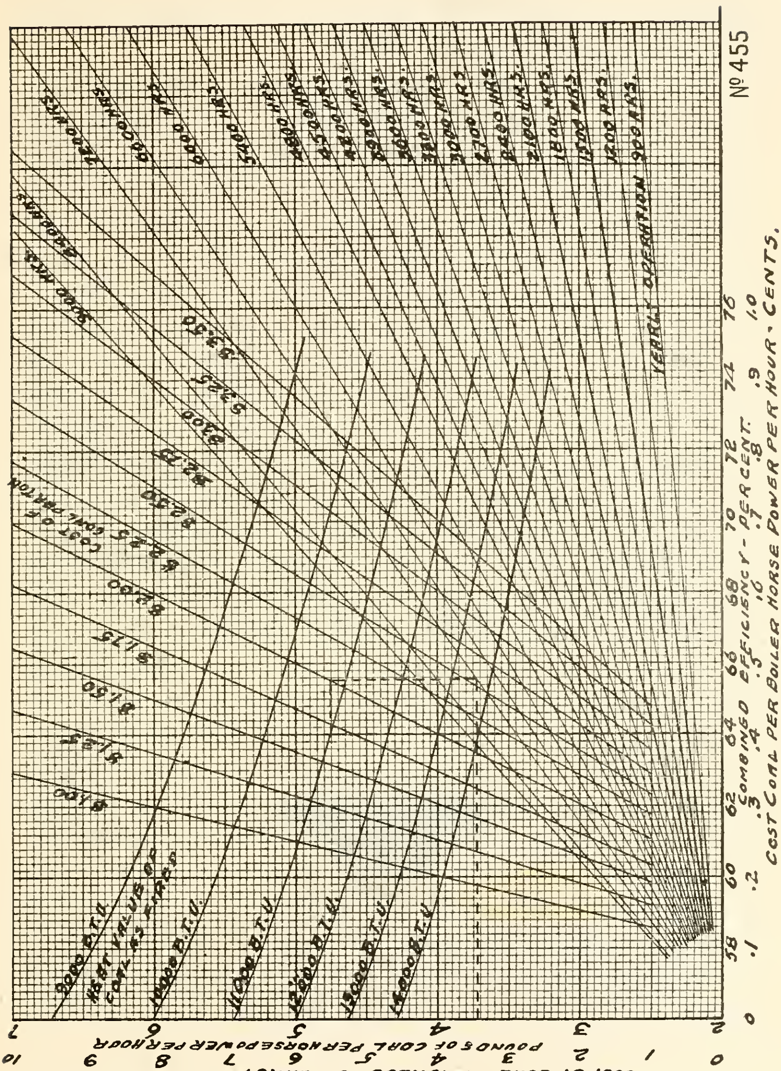
A sample computation will illustrate the method employed.

1 B. H. P. is equivalent to the evaporation of 34.5 lbs. of water from and at 212°, per hour.

To evaporate 34.5 lbs. water from and at 212° requires 34.5×965.7 B. T. U. per hour.

The available heat in a pound of fuel equals the B. T. U. per pound $\times$ the combined efficiency.

Therefore: $\dfrac{34.5 \times 965.7}{\text{B. T. U./lb.} \times \text{efficiency}}$ equals pounds of coal per B. H. P. per hour.


№ 455
YEARLY OPERATION
COMBINED EFFICIENCY - PER CENT.
COST COAL PER BOILER HORSE POWER PER HOUR - CENTS.
POUNDS OF COAL PER HORSEPOWER PER HOUR
COST OF COAL - HUNDREDS OF DOLLARS PER 100 HP PER YEAR.
HEAT VALUE OF COAL AS FIRED
COST OF COAL PER TON

In the curves, efficiencies ranging from 60 to 75 have been used, B. T. U. contents from 9000 to 14000, coal costing from $1.00 to $3.50 per ton, and operating periods from 900 hours to 9000 hours have also been selected as representing the usual limits in bituminous practice.

To use the curves the following procedure is suggested as indicated by the dotted lines, using in this case 64% efficiency, 11000 B. T. U. coal costing $2.00 per ton, with a plant operating 72000 hours per year.

Project up from given efficiency on lower scale to curve showing B. T. U. of coal used. (By projecting to the left the pounds of coal per hour may be secured.) From this point on the B. T. U. curve project to the right, or left, as the case may be, to the curve showing the proper cost of coal per ton. (By projecting down, the cost of coal per B. H. P. hr. will be given.) From this point on the coal cost curve project up or down to the curve showing the number of hours per year the boiler is in opertion. Then project to the left and read off the cost of the coal per 100 H. P. per year in hundreds of dollars.

Intermediate values may be determined with sufficient accuracy by interpolation, and the calculation may be stopped at any point to secure secondary results if desired.

THE RELATION OF THE ENGINEER TO NATIONAL PREPAREDNESS.

Abstract of an address before the Armour Alumni Association, December 18, 1915.

BY DR. ISHAM RANDOLPH

Consulting Engineer, Member of the International Board of Consulting Engineers for the Panama Canal and Chief Engineer of the Chicago Sanitary and Ship Canal.

National preparedness for what? For war!

None of my student auditors know what war means, but fifty years of peace have not been sufficient to dim my realization of its horrors, and I was taught its meanings by living through and in the midst of civil strife, and I pray God that your eyes may never behold, nor your hearts to torn, by the sights I saw and the experiences which with those near and dear to me I endured in the dear old valley of Virginia in the span of life between April 18, 1861, and April 9, 1865. That war cloud burst upon a people unprepared. Brothers armed to fight brothers, and all untrained, they took the field to learn the soldier trade in the hard and bloody school of experience. Had the North been prepared its legions would have crushed the South in the first year of the struggle. Had the South been prepared when the storm broke, today there would be two republican governments in a land which needs but one. Memories are bygones, but they are the records of what we have experienced, and experience is a teacher whose lessons should not be set at naught. Experience has taught this country some hard lessons and it behooves us as a people to remember what unpreparedness has cost us, and it should spur us now to that preparedness which shall prove deterrent to any foreign aggressor. But if such will not be deterred then our preparedness should be such as to foredoom the invader to destruction.

From my civilian viewpoint this country is not in imminent danger of foreign invasion; because it seems to me that exhaustion alone would bring peace to the warring nations of Europe, and exhausted peoples are in no condition to embark upon a

transoceanic invasion. But I would not set up my impressions against the broader vision of our nation's rulers. Diplomacy, which is a sealed book to me, is full of revelation to the trained statesman, and the men who have been placed in power by a sovereign peoples will advise us to prepare.

In the last fourteen years we have had three presidents. All three are now living. In order of succession the first of these is a man of war. On one occasion when speaking with him of the Spanish war I said, "My impression is, Mr. President, that Mr. McKinley did not want the Spanish war." The reply was, "He did not want it, Mr. Randolph, but I wanted it, sir, I wanted it!" He not only wants naval and military preparation on a grand scale, but he is faulting the present administration for not plunging into the European controversy in defense of Belgium. He is the exponent of radical preparedness. His success is for preparedness on a scale which he believes will meet the probable defensive needs of this country, and his ideas, if I rightly interpret a speech which I heard him make on Thursday, December 9, very nearly accord with the program which our president is urging upon Congress.

For this defensive program I refer you to the president's message, which you have probably read, and if you have not done so you should do it. This is not the program of the war college, that board of military and naval experts. The recommendations of that body of experts would put our country upon a war footing as speedily as men could be enlisted and equipment, arms and munitions could be procured, and ships be built. The administration idea is that such an army as we ought to have on a peace basis (our army falls far short of that now) should be at once created and our navy, as our first line of defense, be greatly strengthened.

In addition to placing the army on an adequate peace basis it is further proposed to secure a body of 400,000 disciplined citizen soldiery by enlisting 133,000 each year for three successive years. I am not competent to pass judgement upon such a plan as is now laid before Congress and so I make no comment. Its wisdom or its folly can only be determined now, by omnipotence. But I have done some thinking along these lines and

I am going to take you into my confidence and tell you what I think.

I think, while treading the paths of peace, which we have been doing so unmindfully of war, we should remember the old maxim—was it Franklin who gave it? "In time of peace prepare for war." Until "the world is lapped in universal law" we should remember that strife may come to us and we should not let self defense become a lost art. We should remember that it is not only "the right of a free people to bear arms," but it is the duty of a free people to know how to bear arms effectively. We should have a measure of military training in our public schools and universities. Our military and naval schools should be expanded to receive more students. Our government should keep abreast of any country in the type of arms which it would need in case of war, and the supply of these arms for every branch of the service should be sufficient to equip one million men. The stock of ammunition should be always sufficient for the needs of such an army. The main arms factories and ammunition factories should be located far inland, between the Alleghenys and the Rockies, and supply depots should be located at pivotal points from which lines of transportation would radiate. Our own Illinois is most favorably located for such factory and supply sites. I have taken you into my confidence and if you agree with me you can use your influence to bring these things to pass.

What is the relation of the engineer to national preparedness? The answer to that question is of momentous consequence to our beloved country. The answer is far reaching and no one man can answer it with finality. Before making any attempt to answer that question I will ask what has been the relation of the engineer to national development, and I will give a few citations in reply.

What country can grow and prosper without permanent roadways? Without bridges across its streams? Without railroads involving mighty excavations, great enbankments, long tunnels, great trestles of wood, steel and stone? Without water works, reservoirs, and distribution mains? Without canals with their locks and dams? Without improved river channels and ocean harbors? Without the powers yielded by harnessed waters?

Without mines from which the hidden precious and base metals are brought forth for the service of man? Without furnaces in which the raw ores may be purified and fused into ingots? Without rolling mills and machine shops in which the metals are fabricated for the countless purposes demanded by the worlds most enlightened civilization? My question has not reached its limit of application, but I pause here to give a comprehensive reply.

The relation of the engineer to all of these things is that his has been the directing mind, the genius, that has brought these things forth. Ad that term engineer is catholic, embracing the civil, the mechanical, the electrical, the military, the hydraulic, and the sanitary; men whose combined workings for the common good have produced our national development. Have the men who have produced this development no part in its perpetuation, no obligation to defend that which they have produced? You answer that for me, and though I have not seen a lip move I know that every heart here present responds. They have·and they will! How can they do it? To bring it home, how can you do it? I can think of some ways and your bright minds and loyal purposes will thinks of many more. You must be keen observers. You whose business calls you out of doors should map in your minds the country that you see. Let it become as natural with you to consider the topographical features of the country as it is to know the names of the streets and highways that you traverse. Think when you see a hillside, some day I may be called upon to help defend that slope. How will I do it? Picture to yourself the trench you will dig, the spot on which you will plant a cannon or place a machine gun. When you see a ravine think how in an emergency you would span it with a bridge made of newly felled trees, supported by crib work of short timbers.

Right here I will inject an anecdote which was true fifty years ago, and truth is imperishable. "Stonewall" Jackson had a quartermaster named Mason, one of those men to whom God had given a big intellect, a strong will and physical endurance. Major Mason had never had the advantages of education, and tradition has it that his daughter taught him to read. Before taking up arms he had become a successful contractor. General Jack-

son ordered his quartermaster to bridge a certain stream and his engineers to furnish plans for it. Shortly thereafter the general asked the quartermaster if he had received the bridge plans. The reply came, "I hain't seen any pictures, but the bridge is done." That is the type of man that comes to the front in a country's exigencies. This man had initiative and horse sense. If added to these a man has education what may he not accomplish? The son of this man was a contractor on the Chicago Drainage Canal and under my direction executed nearly five million dollars' worth of work. He was a worthy son of a splendid sire.

There was a time when citadels and fortresses of stone and brick were considered well nigh impregnable and their conquest was accomplished by an investing siege which cut off all supplies from the defenders, making starvation the victor when arms had failed. That idea was shattered half a century ago. The siege guns of the sixties knocked forts into "cocked hats." Fort Sumpter was made a heap of brick bats by gun fire. Were Vauban, Coehoorn and other great military engineers of the past to visit earth today and see the futility of their mighty works when attacked by forty-centimeter guns they would rejoin the hosts of the shades in deep chagrin. The Belgians beileved that their strongholds could resist any attack, but the heaps of ruins that show where the defenses of Liege, Malines and Antwerp once stood show the vanity of opposing steel and concrete to modern gun fire. This failure of costly defenses to defend has driven armies to imitate the moles and dig themselves in. Here is where the mining engineer comes into his own sphere of usefulness. He is used to running headings and holding up shaky roofs with timbers roughly framed. It will interest his mind to imagine when he does these things in the daily course of his work that he is making places of safety for brave men or else that he is running a gallery out beneath the lines held by the foe and will presently blow other brave men to kingdom come and make a breach through which his compatriots can rush on to victory. This suggestion to the field man and the mining engineer has its parallel in every branch of engineering. Take into your work a conception of its use, in defense against a foe, of offense against an invader.

Never let your education trammel your resourcefulness. Learn to work with the tools and the materials at hand when the exigencies of the case separate you from what under normal and peaceful conditions you would demand for use in the job to be done. While maintaining your individuality learn to co-operate with your fellows, to do "team work." The gridiron has given us that wonderfully expressive term for co-operative action. For learning "team work" a splendid school is the engineering company. In the *Engineering Record* for September 11, 1915, is an article by D. A. Tomlinson, Assistant Engineer, Chicago & Western Indiana R. R., describing the training given engineers in the camp at Belvoir on the Potomac River, established by the government for the eastern and middle states. You will find this article both instructing and interesting.

Read also Williamson's plan for compulsory military education. Compulsory sounds harshly in the ears of a free people, but freedom has its limitations. I but repeat the argument rebutting the idea that compulsion is undemocratic as I heard it presented by Ex-Secretary of War Luke E. Wright in an address made before the National Security League recently (boys, join that League), but I can not use his exact words. Ours is a republican form of government—for once, republican and democratic are synonymous terms—and yet we compel our free citizens to pay taxes for the support of the government. Are we undemocratic when we compel our citizens to defend that government with their personal service and—if need be—with their lives? And if we compel them to defend should we not as a preliminary compel them to know how to exercise the art of self defense? Who can answer "no" to these questions?

Then I ask you to familiarize yourselves with the "Gillen Plan" of preparedness. In brief this plan is to put every manufacturer of articles which will be needed by the government in case of war in close touch with the heads of the departments of war and navy. To have standards prescribed for every article which will be needed—take wagons for instance—and have every manufacturing plant keep the specifications and patterns for the government type of the thing which he manufactures so that when needed the appropriate department may issue its oorder for the number needed of the article which will be des-

ignated by its recorded model or pattern number. Gillen claims, and I think the claim is conceded, that by this method equipment and supplies can be delivered more speedily than they could be taken from stock in military depots and the government would be spared the investment in stored goods which would be deteriorating from age.

As an indication of the feeling among engineers in regard to national preparedness I will now read a resolution passed by the Americn Society of Civil Engineers on May 19 last. Richard S. Buck, member of the American Society of Civil Engineers, introduced the following resolution:

"Whereas, The United States is, by reason of the European war, faced by what may at any moment become the most serious crisis in its history; and

"Whereas, A persistent adherence to a policy of peace and of greatly restricted preparation for war requires, in order to meet this crisis, spontaneous, harmonious and diligent action on the part of all classes of the body politic; and

"Whereas, Effective preparation for meeting this crisis will especially demand prompt, efficient and economical organization, not only for creative work on a gigantic scale and of great variety, but also for bringing into existence an enormous and capable fighting force; and

"Whereas, The corps of engineers, and other branches of the army and navy, albeit of the highest grade, may be utterly lacking in numbers to meet the impending demands; and

"Whereas, It may be necessary, in order to achieve success or escape disaster, to create rapidly from raw material a large, many sided fighting force, covering widely scattered territory; and

"Whereas, The membership of the American Society of Civil Engineers is nearly 8,000 and includes men seasoned in all lines of organization, creative and constructive work, and men of all grades of capability and experience in such work; and who are closely in touch with the great body of workers from whom the best grades of the rank and file of all branches of military service can be drawn; and

"Whereas, The American Society of Civil Engineers, either as a body, or through the creation of volunteer bodies of its

members, may be able to render material assistance to the engineer corps and other branches of the army and navy of the United States in the enormous task which they have to undertake;

"Be it Resolved, That it is the sense of this meeting that the American Society of Civil Engineers should, as promptly as possible through its duly authorized officers, confer with the proper federal authorities and place the facilities of its organization at their disposal to assist in developing a reserve corps of engineers to be used as required, either in construction of military works or for active service."

The American Institute of Consulting Engineers has put itself in touch with the War Department and stands ready to respond to any call. By General Order No. 50, 1915, of the War Department, issued August 25, the door has been opened for civilian engineers to enter military service, under prescribed conditions.

If I have in the smallest degree awakened you to the vital relations which the engineer sustains to national preparedness I shall feel that I have contributed my mite to a noble cause. It may seem to you from what I have said that I am one of the "men who delight in war." But that is far, very far from the truth. I abhor strife and bloodshed, but in the defense of our native land we may have to become the executioners of those whose unhallowed feet polute our soil, who have brought upon themselves the just doom of the violent wrongdoer, whose "blood shall be upon their own heads," "whose end is destruction," and though they perish by our hands, yet shall our hands be clean. Men of the Armour Institute of Technology be true to yourselves and you will be true to your country.

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THE ELECTRIFICATION OF CHICAGO RAILWAY TERMINALS

Although we have been possessed of a copy of the report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals for some time, the exhaustive report which has been made public after four years of investigation and study on the part of that body, has remained on our shelf as a possible secret volume to be examined at some future time. And we venture that many such copies of the report, containing some 1175 pages, have thus been quitely forgotten. The address by W. F. M. Goss, Chief Engineer of the Committee, at a recent meeting of a local engineering society, however, occasioned our careful

perusal of the report and which has given us some very interesting conclusions.

The purpose of the organization of the committee was to determine, first, the necessity of changing the motive power of steam railroads to electric or other power; second, the mechanical or technical feasibility of such a change, and third, the financial practicability of such a change. The elimination of the smoke nuisance from steam road operation, which the committee adopted primarily as a working basis, requires the electrification of every mile of track within the city, main line as well as sidings, and which would involve 37 roads, about equal in number to all the roads in the world outside of Chicago with electrified divisions. As several of these roads handle freight exclusively, the switching problem presented the greatest difficulty, and which is apparent when we realize that none of the electrifications so far undertaken in this country have provided for freight handling and switching on an extensive scale and that Chicago's terminals are among the most complex in the world. In considering the reasons for electrification the committee reports that the electrifications of the New York Central and the Pennslyvania in New York City were necessary in a terminal plan which involved long tunnel approaches. Electrification in Chicago could not be justified on these reasons as the terminals are already established and there are no tunnels.

In the estimation of the cost of electrification, the committee considered several systems and which provided very little difference. The net cost plan with an 11,000-volt alternating current (trolley) system involves the expenditure of $178,127,230; the 600-volt direct current (third rail) system would cost $188,132,314, and the 2400-volt alternating current (trolley) system $181,891,122. The third rail system was considered impracticable of application on account of the large number of gaps, while the trolley system would be greatly interferred with by the large number of structures across the track. The advantage of the admitted saving in electric operation is more than offset by the annual deficit of $14,609,743 which would have to be met by the roads.

The committee in its investigation on the effect in reducing the pollution of the atmosphere found that the railroads were not the

principal offenders, and that electrification as a means of smoke abatement will be slight. The committee reports that high pressure steam plants produced 44.5% of all visible smoke emitted within the city limits; metallurgical and other manufacturing furnaces 28.6%; steam locomotives 22% and domestic fires 3.9%. Of the amount of solid constituents of smoke (soot, ash and fuel particles) discharged into the atmosphere, metallurgical and similar furnaces added 64%, high pressure steam plants 19%, domestic fires 8.6% and steam locomotives 5%. Of the volume of gaseous pollution of the air the high pressure steam plants cause 45%, domestic fires 23%, metallurgical and other furnaces 21% and steam locomotives 10.3%. The effect of electrification in reducing the pollution of the atmosphere is summarized in the *Report* as follows:

1. The amount of visible smoke discharged into the atmosphere of Chicago would be reduced..............20%
2. The amount of solid constitutents of smoke (soot, ash, and fuel particles) discharged into the atmosphere of Chicago would be reduced 5%
3. The amount of dust and dirt in the atmosphere of Chicago arising from all sources, would be reduced...... 4%
4. The volume of gaseous products of combustion discharged into the atmosphere of Chicago would be reduced 5%

The committee's report completely embraces the determinations for which it was organized and although admitting that the electrification is technically feasible it is not probable that any such comprehensive plan would be undertaken.

AVOIDING SMOKE, SOOT AND DIRT IN STEAM GENERATION

There has recently been made a very extensive report regarding the abatement of smoke in Chicago with particular attention to that made by railroads. Whether or not any action results from this report it serves to emphasize the magnitude of the problem and the seriousness of improper combustion.

Coal Burning—

Pittsburgh's annual "SOOT FALL" is said to be 1,031 tons

per square mile; the "SOOT FALL" of Glasgow, 820 tons, London, 426 tons. These figures are quoted from the "1914 Report of the Mellon Institute of Industrial Research of Pittsburgh."

Think of speaking of a city's "SOOT FALL" in the same manner in which the annual rain fall or snow fall is mentioned. The present methods of burning coal are such that the annual "SOOT FALL" and its consequent damage is a fact.

The following quotation is taken from "Bulletin No. 49" of the "Bureau of Mines."

> "It has been estimated that in Cleveland, Ohio, the damage amounts to $12.00 per capita per annum. In Chicago, Ill., the damage has been estimated to equal four-fifths of all the taxes levied in that city for municipal purposes, or a sum equivalent to at least 80 per cent. of the cost of all the coal burned in the city."

Some of the principal ways in which this damage makes itself felt are:—

> "By increased expenditures for repairing and repainting exteriors and interiors of buildings, for artificial light made necessary by the decreased amount of sunlight, for laundering and cleaning, and by injury to vegetation."

It damages property by injuring goods on display in shops and factories and by forcing too frequent cleaning and painting of buildings. All this is aside from the question of public health.

The question of how to eliminate objectionable smoke is one of the foremost problems now being faced by municipalities, and we find that practically all cities are engaged in active campaigns in abating smoke.

Engineering organizations engaged in the design and installation of apparatus to eliminate smoke, cinders, soot and dirt deserve credit for the work that has been done during the past decade to improve conditions of health, economy and cleanliness.

The Green Engineering Co. were pioneers in this class of Engineering, starting 19 years ago with the installation of the Green Chain Grate wit hfurnaces suitable for smokelessness and complete combustion. They developed the chain grate with various standard furnaces which have been extensively adopted

and used, and today are highest authorities in matters of combustion and steam generation.

One very desirable feature of chain grates for either coking or free burning coal is that natural draft is usually employed. This means freedom from cinders which are bound to be thrown from stacks with forced draft, and which are equally objectionable as smoke or soot.

Ash Handling—

Ash Handling is everywhere an endless, unsatisfactory and usually a dusty task.

Disposal of ashes without machinery is a continuous nuisance and an expense without any returns. Conveying machinery saves labor but entails much greater expense for replacement on account of wear. In either case ash disposal involves considerable ash re-handling, with shoveling to a barrel or box, trucking or transferring, hoisting or elevating, dumping in or into something, and then reshoveling into a wagon or car. All this effort is accompanied by dirt, dust, obnoxious steam and gases, and a fire hazard is always present.

In power plants, large buildings or wherever ashes are handled, dirt and gases always appear. The unkempt appearance of the premises, damage to decorations and exposed goods and the expense incurred in attempts to maintain reasonable cleanliness, are well recognized annoyances and sources of endless expense.

Many years of study of the engineering principles involved in handling ashes by air has led to the development of the Steam Jet System of ash handling. By this system ashes are raked into an opening in a pipe line at the point where ashes are produced and are instantly conveyed and deposited thoroughly quenched into a tank or bin ready for immediate loading by gravity into a car or wagon.

Suction for creating air flow through the conveyor pipe is produced by one or more steam jets placed in elbows in the pipe line or in straight runs of pipe between the ash intakes and points of discharge. The number and size of the jets depend on the rate that ashes are to be handled, the length of system and the steam pressure used.

The steam consumption per ton of ashes handled varies with

the distances ashes are conveyed, the number of bends and turns in pipe line and the rate that ashes are to be handled.

Systems up to 200 feet long are readily designed to carry eight tons of ashes per hour, which is the limit of a man's capacity to hoe ashes to an intake. Depending on the cost of steam, the distance ashes are carried and the rate of handling, the cost of steam for handling ashes is from three cents to five cents per ton. In plants where steam required might tax the available steam capacity, ashes are handled at periods when the load is off. In many plants blowing off of stem follows dropping of the load and ashes are handled at such periods utilizing steam otherwise wasted.

In all pneumatic ash conveying systems the separation of air and dust can only be effectively accomplished by spraying the ashes with water while in transit. Steam nozzles alone will partly quench the ashes, but water must be added to lay the dust.

The pipe lines of steam jet systems may be run at any angle, elevation or level. These systems may readily be adapted to any building construction or arrangement, and the ash storage tanks may be placed at a location most accessible for wagons for cars.

The entire system is operated by turning valves for steam and water. No machinery with moving and wearing parts is involved, and no aisles are blocked by trucking and the premises are free from dirt and hot gases.

P. Albert Poppenhusen,
President, Green Engineering Co.

TESTS ON THE ELECTRIFIED DIVISIONS OF THE C., M. & ST. PAUL RY. CO.

In the November number of The Armour Engineer Mr. Curtis told of the transmission and contact systems used on the electrified divisions of the C., M. & St. P. Ry. Co. which were operated shortly after the publication of the article. Official tests have been run on the first division which consist of 112.2 miles of main line single track from Three Forks to Deer Lodge, Mont., handling both freight and passenger trains. The tests have obtained very satisfactory results in every respect even exceeding the anticipations of the engineers.

As had been anticipated the tests showed the superiority of the electric locomotive over the steam locomotive in the handling of freight over heavy grades. One test train was run over a stretch of the electrified division between Butte and Janney, a distance of about 10 miles. The grade encountered averaged about 1.66% but two electric locomotives with a 3,000-ton train behind them encountered no difficulty in climbing the hill and were able to stop at any place on the hill, and upon starting regain their former speed. That this is most satisfactory is seen when three large Mallet engines with a train of about 2,700-2,900 tons found it a most difficult task to make the top of the grade.

A test was made of an electric locomotive with a 1,000 ton train between Butte and Piedmont. In this territory the 1.66% grade between Butte and Janney is encountered with a 2% down grade on the other side of the hill. The estimated cost of power was in the neighborhood of $9, but on the down grade over $5 worth of current was returned to the line.

THE PASSENGER ELEVATOR—ITS IMPORTANCE IN ECONOMICS

Mechanical Engineers are much given to retrospection. The term mechanical must here be used in its most general sense—as referring to all phases of mechanics.

We engineers install elevators and elevator machinery and start them on their mission of aiding the human race in its struggle for business and pleasure; and leave them to the tender mercies of the commercial system that adopts them.

It is for the head of a vast mercantile house or corporation, its managers and their subordinates; for the great public that makes use of the elevator and the philosopher who ponders over such things,—to grasp the importance; the significance;—the absolute necessity of these means of getting, not along, but up and down in the world. Like gas and electricity service, like water supply that is called to our aid,—so with elevators. They each undeniably are of supreme importance to the merchant. Without any or all of them there would be no big business,—we should be savages again or at best, insulated rural settlements.

Imagine, if you can, big communities like New York or Paris without passenger elevators,—a four story building would be the vertical limit of our efforts in warehousing structures. Business activities if carried on in such edifices would be spaced over the area of a whole county, instead of being concentrated in the limits of an ordinary city, and what trouble we would have in the shape of communication and that actual contact so necessary to high pressure commercial efforts.

But this is not a plea for elevators. Rather it is to call your attention to some of the things they do for us, set down in cold matter of fact figures. One concrete example will be enough to set you thinking. You can find numerous others just as striking and effective illustrations of the thoughts to be brought out by the instance cited.

On State Street, the great retail thoroughfare of that wonderful American city of Chicago,—in a space less than one half mile in length there are several very large department stores,—the "Big 9" they are sometimes called, the biggest and finest stores of their kind in the world—eight and twenty stories in height. In these stores are no less than 230 passenger elevators, transferring patrons, mostly women, from one level to another for ten or more hours per day. During the busy fall and winter season the number of such passengrs is almost unbelieveable.

These elevators travel 3,000 miles per day, making round trips of three hundred to five hundred feet every four or five minutes and carry thirty to fifty people each trip at a cost of six to eight cents per car mile of travel.

This means 1,200,000 such passengers per day,—one alone of the stores referred to often carries over a quarter of a million people in a day. Grasp these figures firmly. The entire elevated railway system of Chicago, with its four great trunk lines and twelve branches, does not carry so many people coming and going in twenty-four hours—650,000 people at most in a busy day, from midnight to the following midnight. The same stores referred to carried the enormous total shown above in only eleven working hours, 7:00 A. M. to 6:00 P. M.

The movement during the rush period of five hours—from

11:00 A. M. to 4:00 P. M. is carried on at a much greater *rate* than the total carriage would appear to indicate.

A surely interesting sociological study—this address is given solely with that phase of the question in mind—incidental or allied thoughts of great importance thrust themselves upon us—among them; what effect does this stupendous service have upon the recipients—physically and mentally? Is it wise—is it safe? Are there any or many accidents? Are they serious? Is human life sacrificed? If so, to what extent? But that is another aspect of the question.

C. W. Naylor,
Consulting Engineer, Marshall Field and Company.

But he who performs his daily task and passes his examinations so well that he gets fair grades and in the end receives his degree, has not necessarily done his part. Good consistent work is much, but it is not all; in fact, it is only what the university demands in set terms. It obtains the credits and the degree, just as the ordinary laborer earns his daily wage; and it is little more likely to make the student an eminent engineer than the daily wage is likely to make the laborer a millionaire. Initiative and untiring energy to plan and carry out work which is not compulsory are even more essential and effective during the college course than they are at the height of the professional career. It is true that one who is only an ordinary student may awaken when he takes up his professional work and sets for himself a pace which will enable him to reach the top; but as a rule he will never realize that he is not doing his best. He won his degree without great effort; and in his opinion, it necessarily follows that success must come naturally and easily. After a while when it is too late, he finds it does not; then some one else or his luck is to blame, never himself. As a rule, it is easier to reform a drunkard than a drone or an indifferent man.

—Harrington.

CHARACTER

BY LYMAN E. POWELL

President of Hobart College

From his annual address before the Phi Beta Kappa Society at Cornell University.

Character is the power to stand alone even if all about you take another point of view.

Character is social grace. It is the ability ordinarily to get on with others, to turn the chance acquaintance into a real friend. It is no by-product of a model college to stand alone when there is no need. That is, in fact, merely an idiosyncrasy, having no connection with college and never a by-product of the model college.

Character is the ability to see the point of view of others, and a quick readiness to admit that one may possibly be wrong.

Character includes even tact and pleasant address and quick forgetfulness of untoward things. Hew to the line we must, to have the highest character, but, as has been truuly hinted, there is no need to pick up chips.

Character includes the power to discriminate between good and evil, between the important and the trivial, between the service of others and the thought of self, between good citizenship and bad, or, as has too often been said with truth of college men, indifferent citizenship, between thoroughness and superficiality, between truth and falsehood.

* * *

Character gives an absorbing interest in life. It is one of the most important by-products of our best colleges that, out of many interests in life, the graduate chooses one and gives himself with a sense of proportion to that single interest.

No normal person can go through a modern college in these days and not get this feeling of absorption in one thing to the exclusion of many other things perhaps as important, but to which he cannot devote himself without inviting the humorous counsel of Mr. Crothers that there are so many signficant things in life today that we ought to concentrate on all.

One can be an optimist and yet make all these distinctions and hold in mind all these considerations, for optimism, after all, is trained forgetfulness of many things; it is the emphasis of the

true, the beautiful, the good.

I like to think of that wise woman who in giving counsel to a friend in need of it remarked: "I never pick up things that do not belong to me, not even slights."

* * *

Again, character is coming to be regarded as having a closer dependence than in the past on a properly trained body. The model college has no place for the "ungirt loin," and President Foster, of Reed College, is entirely correct in a judgment to which we are trying to contribute both at Cornell and at Hobart —that everybody should have physical training.

Perhaps all institutions will one day agree to abolish intercollegiate sports. I am not yet ready to suggest that credit be given in the college curriculum for physical training, important as it is. I am impressed by the fact that men who have graduated recently seem physically more fit than earlier graduates. Statistics seem to justify this view. As much can meanwhile be gained in colleges with a history, if we think of physical development as a by-product, as though we give it college credit. Why should we not? When we think deeply into the mysteries of life we find that all the things worth while are by-products. Did you ever know anybody to find happiness by seeking it? Duty done faithfully when sometimes weariness is the day's toll may lead to that bright star in the sunset whose other name is joy; but whether it does or not, the duty must be done and every college should make sure that among its many important by-products is the training of the body as a proper setting for the higher life and an aid to the achievement of the same.

The manager of a large copmany in the Middle West told me recently that in filling positions with college graduates he always gave preference to those who had been prominent in students' activities. "It does not matter," said he, "whether the man distinguished himself in athletics, in politics, or in literary activity. It simply means that he is a man of strong will and initiative, a man who can be relied upon to achieve results, without an external pressure." —*Karapetoff.*

COLLEGE NOTES

THE DR. FRANK W. GUNSAULUS HALL OF INDUSTRIAL ART

Not long ago, Mr. and Mrs. William H. Miner visited the educational department of the Art Institute and were deeply interested. It is not strange that these two friends of the Institute, who have made so much of Industrial Art in the apparently remote department of farm life, at what is known as Heart's Delight Farm, on Lake Champlain ,should have observed with care and enthusiasm what has been done and is being done in the education of young men and women here. It was a joy to the officers of the Institute who accompanied them on their visit here to feel how certainly the application of æsthetic principles and ideals to the affairs of common life found quick response in their minds. Now the result is a gift of fifty thousand dollars for a hall which shall be devoted to the exhibition of objects of Industrial Art.

It comes to the institution at the moment when the truth is realized that a gift at an important juncture is multiplied many times in its significance and worth. This hall will be a home for valuable collections which have not hitherto been properly related. Such collections as may come in the future to increase

our possessions in the realm of Industrial Art will be so cared for in connection with what we already have, that the thousands of students who are at the Institute, or are to come to the Institute, shall have an adequate and, indeed, a magnificent laboratory.

The Amelia Blanxius Collection of British pottery, which has been succeeded by the collections of Wedgwood and Persian pottery, and is associated with the continental pottery already assembled, will doubtless be associated in time with oriental potteries, and it is hoped that some one with the same spirit of generosity as has been manifested in this gift will see to it that Italian and Spanish majolica shall not go unrepresented. There is a large field for those who may be persuaded to give toward the growth and development of Industrial Art, either by assuming the expense of building other halls for distinct purposes or by the generous creation of a fund for the purchase of such objects of art as are now sure to come upon the market because of the European war.

No one can be present on the occasion of the visit of the school children of our city to the Art Institute without realizing what a substantial and far reaching benefit would accrue from the gift of a hall of similar size for the work of children. The product of the Industrial Art movement which has been so largely European in the past, is sure to be in the hand of the young American very soon, as his achievement. Our location in the central west gives a unique opportunity to any one who will build another hall or endow this children's work so that the influence and teaching of the Art Institute may radiate throughout the whole country. Certainly this gift of the hall for Industrial Art offers a most inspiring example to those who would guide and strengthen the most important currents of our new American life.

The hall will bear the name of Dr. Frank W. Gunsaulus.

—*Bulletin of The Art Institute of Chicago.*

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

President .... John B. Byanskas
Vice-president .... Bradley S. Carr
Secretary .... E. S. Echlin
Treasurer .... Lincoln W. Luckow

The December meeting of the Armour Branch of the American Society of Mechanical Engineers was held on December 2, 1915.

The meeting was addressed by Mr. Bradley S. Carr, of the Senior Mechanical Class, on the subject of "Grip Nuts." Mr. Carr explained the entire process of the making of grip nuts and by means of a Riehle Testing machine demonstrated the locking power of the Grip Nuts. Mr. Carr is with the Grip Nut Company of Chicago.

Following the talk by Mr. Carr, an open discussion was held on the subject of "The Testing of Glued Wood Surfaces for Tension." This new plan of having open discussions has proved to be a very popular one. —*E. S. Echlin.*

THE CIVIL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President .... H. A. Rook
Vice-President .... L. J. McHugh
Recording Secretary ....H. W. Hemple
Corresponding Secretary .... R. S. Adams
Treasurer .... F. A. Armstrong

On Tuesday, November 2, 1915, the members of the Civil Engineering Society were entertained by Professor M. B. Wells on "The Construction of the Chicago Drainage Canal." Professor Wells illustrated his talk with many lantern slides showing the many different methods of handling earth and rock excavation. Many costly experiments, a large number of which proved failures, were made in an effort to handle the excavation in a more efficient manner.

At the fourth meeting of the society, held on Nov. 23, 1915,

the address was delivered by Dr. Gerber, who spoke on "The Exigencies of Camp Life." Dr. Gerber has had a vast experience as Chief of surveying parties and was able to speak quite extensively on the work done by field parties in railroad location. The various items necessary toward the making of a successful camp were enumerated by Mr. Gerber.

INSPECTION TRIP.

On Friday, December 10, 1915, the Senior and Junior Civil Engineers visited the new Field Museum now in process of construction at the foot of Twelfth Street. The building covers an area of 206 feet by 438 feet and when finished will be three stories high. The concreting operations are very interesting, the concrete being mixed by a gravity mixer and placed by means of chutes. The construction work is being carried on by the Thompson-Starrett Company, the estimated cost being $5,100,-000.00. When completed the Field Museum will be the largest marble building in the world.

—*H. W. Hemple.*

THE CHEMICAL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President .... G. B. Perlstein
Vice-President .... J. K. Goorsky
Secretary .... S. Butterman
Treasurer .... N. Isenberg

The next meeting of the society will occur shortly, at which time an interesting talk is assured.

There has been an active movement to provide a series of instructive lectures for subsequent meetings and it is hoped that there will be an attendance from members of the other departments to whom a cordial invitation is extended. The society is contemplating the continuance of the plan temporarily adopted, of holding meetings in the late afternoon, rather than in the evening as has been the custom, in view of the convenience it may provide, as indicated by the large attendance at the previous meeting.

—*S. Butterman.*

THE FIRE PROTECTION ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

President .... L. Peterson
Vice-President .... W. A. Tronvig
Secretary .... A. Corman
Treasurer .... R. F. Schreiner

The Fire Protection Engineering Society was given a real treat on Tuesday evening, November 23, in the form of a very interesting and concise lecture by Mr. G. B. James, Assistant Chemical Engineer, Underwriters' Laboratories, on "Oil Fires in Oklahoma and Texas." Mr. James has been working on the problem of the prevention of these immense fires for several years and has been honored for his work by receiving the degree of Chemical Engineer from the Institute. Thus there could be no one more welcome within the walls of the "Tech" building than our aforementioned guest and lecturer.

Mr. James' unique lecture may be briefly divided into the following main topics:— (1) causes of the oil fires; (2) extent of losses; (3) precautions taken; and (4) extinguishing of the fires. As to the causes of these amazingly huge fires, ninety-nine per cent (99%) may be said to be due to lightning and about one per cent (1%) to flame contact. Some of the precautions taken were the grounding of pipes, the installation of steel roofs on storage sheds and the building of steel storage tanks provided with steam connections for extinguishing the fires.

Mr. James pointed out that steam was not sufficient to extingusih these large fires and that other means had been devised. This led to the most interesting part of the lecture; i. e. the use of the so-called foam solution as an extinguisher. The foam is formed by the reaction, most likely of sulphuric acid, sodium or calcium-bicarbonate and tan bark. The latter constituent makes it differ from the ordinary fire extinguisher. Most of the extinguishers work automatically and give off the foam when the temperature about the container rises to a certain point.

Mr. James then illustrated the operation of these extinguishers in a number of clear-cut and very educating slides. In one

slide a burning oil lake was shown being extinguished in forty seconds. In another 50,000 barrels of burning oil were put out in one and one-half minutes by two extinguishers, one on each side. Many other interesting slides were shown until the final group illustrated how one oil fire was extinguished by removing the burning gases by means of a smoke stack. This completed Mr. James' magnificent lecture.

The meeting was adjourned after the Society had extended a hearty vote of thanks to Mr. James for one of the most interesting lectures the Society had yet enjoyed.

On Tuesday, December 7th, a very snappy business meeting was held. The members present were unanimously in favor of reducing the dues. The reduction was first attempted by a motion to suspend dues for one semester. This, however, was not carried and a direct motion to reduce the dues from one dollar to fifty cents a year was unanimously voted in favor of. The Society also did away with the business meeting entirely and decided to hold one lecture each month. Suggestions were made that the lecture be made more of a social gathering for the Society and toward this end the Sophomores volunteered to act as a social committee. President Peterson announced that the lecture scheduled for December 14 was postponed to January 11.

The lecture for the evening of January 11 will be given by Mr. S. V. James, Mechanical Engineer, Underwriters' Laboratories, on "Safety Engineering." —*A. Corman.*

* * *

Among some old Egyptian articles being classified by members of the faculty at U. of P. were found a pair of loaded dice. The faculty found them to be in good working order. Evidently the Egyptians were wiser than is sometimes thought.

* * *

If someone in the near future were to notice an abundance of rats at the University of Illinois and trace them to their homes, he would find that the door to the new Genetics building had been left open for in that building there will be a collection of over 3,000 rats and mice. The building will also have a great many insects and small animals in it.

At the recent meeting of the Little Five Athletic Association resolutions were passed permitting athletes representing the Little Five athletic conference to play summer ball for money, as was the case for the last two seasons, and in addition allowing these same students to take up country or municipal playground work for remuneration without endangering their amateur standing as far as the Little Five is concerned.

Peace was established with the Illinois Intercollegiate association, commonly known as the Big Eighteen, and from now on contests in all lines of athletic endeavor will be permitted between the two associations. In previous years members of either body would not engage in any sport with the other which always left many claimants for the championships among the smaller colleges.

The informal awards of titles were as follows: Football, Monmouth; baseball, ARMOUR; track, Monmouth; basketball and tennis, Lake Forest.

H. G. Ghormley of Monmouth was chosen president after W. K. Smart, who held the office for two years, asked to be relieved of the duties. The other officers chosen were:

Vice-President—C. E. Young, Beloit.

Secretary—R. P. Sibley, Lake Forest.

Treasurer—F. U. Quillin, Knox.

Auditor—W. K. Smart, Armour.

The following dates for baseball and track meets were selected:

April 22—Beloit at Lake Forest.
April 28—Armour at Knox.
April 29—Armour at Monmouth.
May 5—Knox at Armour.
May 6—Knox at Armour.
May 12—Monmouth at Armour.
May 13—Monmouth at Lake Forest.
May 19—Monmouth at Knox.
May 26—Lake Forest at Knox.
May 27—Lake Forest at Monmouth.
May 30—Knox at Monmouth.
June 3—Beloit at Lake Forest.

TRACK.

May 20—Conference track meet—At Knox.
May 13—Monmouth at Knox.

CALENDAR OF CONVENTIONS AND EXHIBITIONS

January 17-18—Boston, Mass.

AMERICAN FORESTRY ASSOCIATION. Executive Secretary, P. S. Ridsdale, 1410 H Street, N. W. Washington, D. C.

January 18-20—New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS. Secretary, J. J. Blackmore, 29 West Thirty-ninth Street, New York City.

January 19-20—New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Secretary, Charles Warren Hunt, 220 W. Fifty-seventh Street, New York City.

January 20-22—Minneapolis, Minn.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION. Secretary, Alvin E. Dodd, 140 W. Forty-second Street, New York City.

January 26-28—Urbana, Ill.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS. Secretary, E. E. R. Tratman, Wheaton, Ill.

February 8-10—Washington, D. C.

CHAMBER OF COMMERCE OF THE UNITED STATES. General Secretary, Elliott H. Goodwin, Riggs Building, Washington, D. C.

February 12-19—Chicago, Ill.

NINTH CHICAGO CEMENT SHOW. Secretary, R. F. Hall, 208 South LaSalle Street, Chicago, Ill.

February 15-18—Chicago, Ill.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING. Secretary, J. P. Beck, 208 South LaSalle Street, Chicago, Ill.

THE AMERICAN ASSOCIATION OF ENGINEERS

There are few publications today which hold the distinction of being published solely in the altruistic interest of a class and whose columns are closed to any form of advertising not of direct "welfare" or "educational" interest to that class.

The American Association of Engineers being devoted to the

following objects, "TO RAISE THE STANDARD OF ETHICS OF THE ENGINEERING PROFESSION AND PROMOTE THE ECONOMIC AND SOCIAL WELFARE OF ENGINEERS," has taken a field which is filled with virgin opportunities and its Board of Directors have wisely undertaken an optomistic enterprise with due regard to the possible evils of exploitation by the over enthusiastic or shortsighted.

The safeguards proclaimed through the following resolution inspires the interest of the earnest conservative as well as exhibits a spirit which will please the most progressive elements of the great body composing the engineering professions:

Resolution passed by the Board of Directors of the American Association of Engineers, January 3, 1916.

Whereas, It is the purpose of this Association to publish an official journal for the advancement of all Technical Engineering Professions, and

Whereas, The emblem of this Association is the ancient sign, the Monad, which represents the principles of philosophy and productive evolution, and

Whereas, Each local chapter of this Association will be enabled to give voice through this medium concerning local and national affairs of interest to their members and all engineers, and

Whereas, It is the purpose of the National organization to devote its journal exclusively to matters of direct interest to the Engineering Profession.

Therefore Be It Resolved:

FIRST—The Journal shall be issued monthly under the title of "The Monad."

SECOND—That a portion of its space shall be divided into per capita allotments to each local chapter and for which each chapter shall be made responsible, both as to the matter appearing therein and for proportional costs.

THIRD—That no outside advertising be solicited or accepted which does not have a direct appeal to Engineers in which their welfare is concerned or valuable information to the engineering profession is displayed.

In an interview with the Publicity Committee of the American Association of Engineers, it was explained that the first issue will appear about January 15th and will cover the history

of the Association up to and including the recent National Convention together with certain papers and transcripts of addresses as were included in the Convention Program.

The A. A. E. will direct its efforts to co-operation with individual engineers, all Scientific Societies, Associations and Local Clubs and the technical and trade press for the realization of its objects and therefore such institutions who recognize the needs calling forth this new enterprise should take this opportunity to place themselves in communication with the A. A. E. for the purpose of exchanging literature and forwarding the welfare of the Technical Professions.

The American Association of Engineers desires to arrange for a "Monad" correspondent in every Technical organization, whereby information may be collected which will make the new Journal of direct interest to every Engineer.

It is estimated that there are over 100,000 engineers in the United States, 60,000 of which are not identified with any Engineering Association and it is to this latter class which the A. A. E. desires to make its strongest appeal. It is a *business association* for the advancement of the "TECHNICAL MAN" and naturally it must fall to the lot of the 40,000 associated men to bring about a complete amalgamation. Therefore, "The Monad"—An exclusive Engineer's Journal devoted to the economic and social welfare of the Engineering Class—A hand book, pocket size, composed only of words useful to the work, study and play of the Technition.

CREOSOTED TIMBERS TESTED.

Tests of woods were made recently by the city of Portland to determine the relative strengths of creosoted and untreated timbers. Specimens 14 feet in length and 7 by 14 inches cut from the same tree showed little difference in strength, whether creosoted or not. The breaking point was reached at 49,000 pounds.

TRADE NOTES AND PUBLICATIONS

Under this heading we will note all publications which have been received and which contain articles of merit and of interest to the engineer. These publications are available free of charge for readers of THE ARMOUR ENGINEER and we will be pleased if you would mention THE ARMOUR ENGINEER when writing for this material. Advertisers are invited to submit catalogues or bulletins suitable for mention in these columns.—The Editors.

William Andrews, Inc., 120 Liberty St., New York, have issued a very interesting pamphlet on the Deoleizer, an instrument, as the name signifies, for removing oil from emulsions. The record of the Deoleizer (by the ether test) is the removal of 9,999,994 parts in 10,000,000 from an emulsion of oil and water. The oil remaining is therefore equal to one drop in one and a quarter barrels of water.

"Bruce-MacBeth Gas Engines and Some Valuable Facts about Gas Power" is the title of a booklet issued by the *Bruce-MacBeth Engine Co.,* 2103 Center St., N. W., Cleveland. The booklet covers Producer Gas Plants, Bruce-MacBeth Engineering Service, Obtaining Maximum Efficiency from Private Power Plants, the Meriam Steam Process, and some useful data for the operator of a gas power plant.

Bulletins Nos. 13 and 14 of the *Morse Chain Co.,* Ithaca, N. Y., have been received. The bulletins illustrate and describe the Morse Silent Chain and show applications in textile mills and a few of the many large power drives. Data is given to be used in the design of Morse Chain Drives.

"The Use and Abuse of Ball and Roller Bearings," by F. J. Jarosh, Chief Engineer of the Bearings Company of America, is the title of a series of articles published in "Graphite," the monthly publication of the *Joseph Dixon Crucible Co.,* Jersey City, N. J. The article contains valuable information for the proper use and treatment of ball and roller bearings and offers many suggestions and rules.

"Water Lifted by Compressed Air," and "Calyx Core Drills" have been received from the *Ingersoll-Rand Co.,* 11 Broadway, New York. The catalogues record many interesting experiences and contain many illustrations.

Westinghouse, Church, Kerr & Co., 37 Wall Street, New York City. Bulletin No. 16. Calls attention to a record which was made in the building of a 12-mile railroad in less than five months at a total cost of considerably less than $150,000. A brief statement of the features of the work is given supplemented by views along the right of way.

American Metal Products Company, 309 Lisbon Avenue, Milwaukee, Wis. Pamphlet. Contains a brief discussion of what metals are and how they are obtained from their ores, followed by a brief historical account of the use of copper, brass and bronze. Attention is next called to Ampco bronze, which is free from tin, zinc, lead or phosphorous and resists the action of all ordinary acids and corroding influences. The use of this metal for die castings is touched upon, followed by a description of its properties.

The bureau of mines, department of the interior, has issued an interesting pamphlet entitled *"The Buying and Selling of Ores and Metallurgical Products,"* by Charles H. Fulton. The pamphlet covers the methods of buying, sampling and selling ores of copper, lead, zinc and other non-ferrous metals and also includes interesting data on the methods of marketing the metals themselves.

The Foxboro Co., Foxboro, Mass., recently has published an exceedingly comprehensive 40-page catalog devoted to its line of recording gages. No multiplying devices are found in the actuating element, which might cause loss of motion or would have a tendency to get out of order. All movements are positive in their action. The company's recorders are made in three sizes, 8, 10 and 12 inches, for any range from full vacuum up to 20,000 pounds pressure per square inch. Among the different products described and illustrated are standard round form instruments, two-pen recording gages, suppressed scale recording gages, recording gages with electric alarm attachment, portable recording gages with and without U gage, helical and diaphragm tube movement, devices for protection against moisture, dust and fumes, differential recording gages, charts, chart files, chart holders and recording instruments for gas and creosoting plants.

"The Coking of Coal at Low Temperatures With Special Reference to the Properties and Composition of the Products,"

by S. W. Parr and H. L. Olin, has been received as Bulletin No. 79 of the Engineering Experiment Station of the University of Illinois.

The Bulletin is a continuation of the work of the authors described in Bulletin No. 60. In their present investigation apparatus was used which attained of a capacity sufficient to yield quantities permitting a detailed study and also embodied the principals of a commercial equipment.

One of the interesting facts put forth is the adaptability of a smokeless fuel to domestic purposes.

"Wind Stresses in the Steel Frames of Office Buildings" has been issued as Bulletin No. 80 of the Engineering Experiment Station of the University of Illinois.

The authors, W. M. Wilson and G. A. Maney, have made a detailed critical analysis of such stresses and incidentally have computed the stresses in a twenty-story building by the exact method.

The Bulletin presents a more accurate method for determining the stresses and demonstrates the inaccuracy of the method used. The approximate method given is more exact than the method ordinarily used.

The Engineering Experiment Station of the University of Illinois has issued Bulletin No. 82 on "Laboratory Tests Of A Consolidation Locomotive,' by E. C. Schmidt, J. M. Snodgrass and R. B. Keller.

Inspection and Tests of Materials for Highway Bridges; Inspection and Testing of Paving Brick. Two pamphlets giving standard specifications for highway bridges and paving brick, adopted by American Society for Testing Materials. Robert W. Hunt & Company, 2200 Insurance Exchange Building, Chicago, Ill.

Luten Design Bridges. Booklet containing construction views of the more important reinforced concrete bridges of Luten design under construction in the spring of 1915. Daniel B. Luten, Indianapolis, Ind.

THE ALUMNUS

Being That Part of **The Armour Engineer** Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

T. A. Banning, Jr. F. T. Bangs W. A. Kellner

Communications should be addressed to T. A. Banning, Jr. 1632 Marquette Bldg., Chicago, Ill.

THE MID-WINTER BANQUET.

The annual mid-winter reunion and banquet of the Armour Alumni Association was held in the East Room of the Hotel La Salle Saturday evening, December 18, 1915. The meeting was one of the most successful mid-winter meetings ever held, except in point of attendance. The menu and the entertainment provided were of exceptional quality. Blended with the good food were a large number of songs well rendered by the Imperial Quartette.

After dinner Master of Ceremonies A. B. Benedict, '04, introduced H. W. Clausen, '04, who made a few remarks about the progress of the Twenty-fifth Anniversary Celebration Committee. Pledges of financial support were secured from those present. Professor E. H. Freeman was called upon as a representative of Armour Institute and he responded by saying he

wished to speak as an alumnus. However, his talk chiefly concerned Alma Mater activities. He outlined the necessity for teaching business methods in connection with technical training and spoke briefly of the tendency of the faculty of Armour Institute toward including such training in all courses.

The principal address of the evening was made by Dr. Isham Randolph, consulting engineer, member of the International Board of Consulting Engineers for the Panama Canal and chief engineer of the Chicago Sanitary and Ship Canal. His subject was "The Relation of the Engineer to National Preparedness." The address is printed on other pages of this issue where it may be read by those who were unable to hear it. Dr. Randolph's topic was timely and absorbing, and the interest shown was augmented by many personal anecdotes.

The meeting was then turned over to President T. A. Banning, Jr., in order to dispose of the business of the Alumni Association. The resolution to reduce the qualifications for eligibilty to associate membership from two years' work to one year's work at Armour Institute met with opposition and when put to a vote was defeated. The majority of those present expressed the opinion that it was better to keep the qualifications for membership high; it was felt that the number of graduates was large enough to insure an active organization and that steps should be taken to increase the membership from the list of graduates rather than from a list of one-year ex-graduates. The resolution to hold meetings any time during the months of December and May or June was passed without opposition.

Treasurer H. E. Beckman reported that the paid-up membership for 1915-16 numbered 263; that of 1914-15, 246; and 1913-14, 293, showing a decrease this year in comparison with two years ago, and an increase over last year's figures. It is probable that a campaign for an increase in membership will be instituted, and we ask those alumni who read to anticipate it by bringing some of their classmates to meetings and interesting them in the affairs of the Association.

A report of the scholarship fund committee showed considerable money available for loans. After the report had been read W. T. Dean, '04, suggested that a canvass of the men of the different classes in attendance be made in order to secure life

memberships in the Association. L. A. Sanford, '02, and Elijah Lewis, '02, were the first to join. Pledges were secured from A. Wagner, '03, E. R. Burley, '13, P. F. Griffenhagen, '13, R. J. Koch, '13, F. T. Bangs, '13, J. T. Lucas, '13, and M. V. Stecher, '14.

The attendance at the meeting was 76, the class of 1899 having the highest percentage present and the class of 1913 having the largest number present, closely followed by the class of 1914. There was quite a falling off in total attendance in comparison with the last two years, and the officers of the Association deftly put the blame onto the war. If the war is responsible, let us hope for peace and prepare in case there is war next December.

ALUMNI MEETING AT PITTSBURG.

A meeting of Armour graduates was held at the Ft. Pitt Hotel, Pittsburgh, Saturday evening, December 11, 1915. After handshakes and dinner an organization was formed and it was agreed to hold a meeting next May and twice a year thereafter. J. D. Bradford, '13, was elected secretary. His address is care of H. Koppers Co., Pittsburgh, and all alumni interested in the activities of a Pittsburgh organization should communicate with him. Those present at the December meeting were C. M. Moss, '02, Dean Harvey, '00, J. E. Saunders, '07, C. R. Riker, '06, E. B. Crane, '09, Irwin Newman, '13, J. D. Bradford, '13, and R. B. Ambrose, '11, and several ex-graduates.

J. E. Saunders, who reported the above meeting, also reports that through the kindness of Dean H. M. Raymond and Comptroller F. U. Smith an Armour pennant has been hung in the Westinghouse Club House, Wilkinsburg, Pa. A number of photographs of Armour Institute have been received from the same source and these will be framed and hung in the clubhouse. The members of the club are technical graduates from all over the world who are taking apprenticeship courses at the Westinghouse Electric & Manufacturing Co., Westinghouse Air Brake Co., Westinghouse Machine Co., and the Union Switch & Signal Co.

ALUMNI NOTES.

1899.

L. F. Mahler, besides being manager of the Universal Shoe Machinery Co., is president of the Dobyne Realty & Investment Co., St. Louis. He expresses his regrets for being unable to attend the meetings of the Alumni Association.

1902.

W. H. Lang is at the present time in Panama where he is attending some of the business interests of Phillips, Lang & Co., contracting engineers, Fisher Bldg., Chicago.

H. R. Harbeck and I. D. Miller have organized the Harbeck-Miller Construction Co., with offices at 355 Ashland Avenue, River Forest, Ill.

1903.

W. W. Felt is now working for the General Chemical Co., Chicago Heights, Ill.

O. R. Prescott has recently accepted a position with the American Coal & By-Products Coke Co., 608 South Dearborn Street, Chicago.

1904.

George Manierre has established the Manierre Engineering & Machinery Co., 622-3 Colby-Abbott Bldg., Milwaukee, Wis.

1905.

J. F. Kadic is now employed by the Electromotor Co., 32 South Clinton Street, Chicago.

W. E. Hill is teaching at the Parker High School, Chicago.

1906.

V. A. Houghton is now secretary and treasurer of the O. C. Keckley Co., 608 South Dearborn Street, Chicago.

R. S. Torrance has gone to Fairfield, Ia., where he is connected with the Fairfield Public Service Co.

1907.

B. C. Hooper is associated with the American Sunday Magazine Corporation, 220 Fifth Avenue, New York City.

Balthasar Hoffman, Sr., formerly engineer for the Smoke Abatement Committee, City of Chicago, is with the Improved Combustion Co., 355 Peoples Gas Bldg., Chicago.

A. L. Kubitz is working for the Public Service Co., 114 North Oak Park Avenue, River Forest, Ill.

1908.

C. W. Morgan is in the manufacturing business, with offices at 1336 Michigan Avenue, Chicago.

G. F. Wolters is now working for F. D. Chase, architect and engineer, 1345 Peoples Gas Bldg., Chicago.

1909.

P. G. Downton, who has been employed in the Chicago offices of the Electric Storage Battery Co. for some years, has been transferred to the Minneapolis offices of the same company. Before leaving for Minneapolis in October Mr. Downton was married to a Chicago girl and they are now snuggly nested at 2439 South Emerson Avenue, Minneapolis.

B. F. McAuley is working in the Engineer of Tests' department, C. & N. W. railway, Keeler Avenue and Kinzie Street, Chicago.

E. W. Petty is now employed in the Department of Public Service, City of Chicago, 613 City Hall.

The death toll of the Eastland, which numbered so many hundreds, July 24, 1915, included Leslie E. Simmons, who was employed in the inspection department of the Western Electric Co. The sincere sympathy of his classmates and all alumni is extended to his bereaved family.

The treasurer has received a very interesting letter from E. B. Crane, interesting to the treasurer because he pays a year's dues to the Association, and interesting to the alumni because he tells some of his activities. He states his wish to meet "the bunch" once again, having never been able to attend one of the Association meetings since his graduation. Mr. Crane is working for the Youngstown & Sharon Street Railway Co. This company is building twenty-five miles of 66,000-volt transmission line and he has been buying right-of-way for the line. He says to be sure and give his best wishes to all '09 men.

1910.

W. G. Jens, formerly with H. M. Byllesby & Co., is with the Red River Power Co., Grand Forks, N. D.

J. G. Hatman has left Kansas City and is in the employ of the Semet Solvay Co., Ensley, Ala.

R. G. Eliel is now employed by the Chicago Union Station Co., 521 West Adams Street, Chicago.

H. W. Martin is working for the Wisconsin Consulting Laboratories, 220 Greenbush Street, Milwaukee, Wis.

1911.

H. M. Alling, who has been in New York City for some time, is back in Chicago again, and is with the New York Underwriters Agency, 2163 Insurance Bldg.

H. L. Butler is working for the Interstate Commerce Commission, 914 Karpen Bldg., Chicago.

Harvey W. Jones is now employed by the Toltz Engineering Co., Pioneer Bldg., St. Paul, Minn.

A. H. Packer is working in the automobile equipment department of the Westinghouse Electric & Manufacturing Co., 2007 Michigan Avenue, Chicago.

W. A. Stevens is employed by Holabird & Roche, architects, 1400 Monroe Bldg., Chicago.

1912.

C. W. Collins is in the sales department of the Barrett Manufacturing Co., Otis Bldg., Chicago. He does most of his selling at the state capital.

J. J. Newman is working for the Sanitary District of Chicago. He has just returned from New Jersey where he had some very interesting work in sanitary problems for the New Jersey State Board of Health. His address is 4812 Indiana Avenue.

W. S. Oehne is now working for Sears, Roebuck & Co., Homan and Kedzie Avenues, Chicago.

All alumni who knew Edward V. Dewalt will be greatly shocked to learn of his death, which occurred October 19, 1915, at the St. Luke's Hospital. He was born in Bloomington in 1886. His illness was of a cancerous nature, for which he underwent two operations last spring. During the summer he was convalescent and seemed to be improving in health, but in September another operation was necessary and he did not survive. A very conscientious student, interested in all student activities,

a likeable fellow who made friends of every one he met, his death was most untimely, and will be mourned by his friends.

N. W. Strale has returned to Chicago and is working for the Federal Furnace Co., 108th Street and Calumet River.

L. H. Roller, who has been employed in the engineering department of the Western Electric Co. for the past three years, has returned to the employ of Gardner & Lindberg, consulting engineers, Marquette Bldg., Chicago.

1913.

A. F. Holden, Jr., who is working for the Fire Underwriters Inspection Bureau, has been transferred from Portland, Ore., to Salt Lake City.

E. A. Hager is back in his home town of Pueblo, Col., and is working for the Colorado Fuel & Iron Co.

H. F. Israel is employed by H. Almert, engineer, 209 South La Salle Street, Chicago. He joined the ranks of the benedicts last summer.

Irwin Newman has remained with the H. Koppers Co., which moved their offices from Chicago to Pittsburgh. His address is 5434 Howe Street.

A. J. Schuette is chemist fo rthe Illinois State Food Commission, 1605 Manhattan Bldg., Chicago.

1914.

C. A. Dean is at present employed by the Indiana Inspection Bureau at Evansville, Ind.

E. W. Menke is working for the Bates Valve Bag Co., 1463 McCormick Bldg., Chicago.

J. C. Norton is with the G. C. & S. F. Railway, Galveston, Texas.

M. W. Stecher is working for the Western Union Telegraph Co., Western Union Bldg., Chicago. "Stech" is the first '14 man holding a life membership in the Alumni Association.

J. W. Turner is now employed in the estimating department, Jos. T. Ryerson & Sons, Chicago.

R. W. Whitmore is in the power plant department of the Milwaukee Electric Railway & Light Co., Public Service Bldg.

1915.

F. L. Brewer is working for the C., B. & Q. railway, 935 La Salle Street station, Chicago.

L. W. Bunge is employed by the Elmes Engineering Works, Morgan and Fulton Streets, Chicago.

E. J. Burris is working in the electrical engineering department of the C., R. I. & P. railway, Fifty-first Street shops, Chicago.

J. L. Duffy is employed by the C., B. & Q. railway, 547 West Jackson Boulevard.

F. W. Hook is working for the Peoples Gas Light & Coke Co., Peoples Gas Bldg., Chicago.

John Jucker, Jr., is with H. B. Barnard, building contractor, Marquette Bldg., Chicago.

W. L. Juttermeyer has accepted a position with the Aluminum Ore Co., East St. Louis, Ill.

Yoshisaku Hirose and I. Yamamoto have formed a partnership and are doing engineering work, with offices at 143 North Wabash Avenue, Chicago.

A. N. Grossman is with the Solva Waterproof Glue Co., 2519 Jefferson Avenue West, Detroit, Mich.

E. R. Marx is working for Jos. T. Ryerson & Son, 2558 West Sixteenth Street, Chicago.

J. L. Mayer is with the John O. Heinze Co., Shuey Bldg., Springfield, O.

R. C. Palmer has a position with the Illinois Engineering Co., 5021 South State Street, Chicago.

T. K. Pfafflin is with the Manufacturers Mutual Fire Insurance Co., 1321 Marquette Bldg., Chicago.

Ernst Sieck is working for the American Coal and By-Products Coke Co., 608 South Dearborn Street, Chicago.

A. G. Stark is employed by Webster Tomlinson, architect, 54 East Van Buren Street, Chicago.

G. F. Wetzel is working for the International Filter Co., 38 South Dearborn Street, Chicago.

H. E. Willson is with the Illinois Steel Co., Joliet, Ill.

W. M. Bready, Jr., has gone to Kansas City, Kan., where he is employed in the engineering department of the Kennicott Co. His address is 1101 State Street.

Jee-kwun Wong is taking post graduate work at the University of Minnesota.

THE ARMOUR ENGINEER

Index to Volume VII, 1915.

There has been in the past few months, several requests for the index to Volume VII of THE ARMOUR ENGINEER which is here given. The index to Volume VIII will be given in the May issue.

GENERAL

MECHANICAL

ELECTRICAL

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THE M. E. P. OF A GAS ENGINE

BY DANIEL ROESCH

Assistant Professor of Experimental Engineering, Armour Institute of Technology.

One of the most important factors in current gas engine design is the production of maximum power for a given cylinder bore and stroke.

This resolves itself, primarily, into a problem of producing the greatest Mean Effective Pressure, secondarily, in making the greatest possible percentage of the piston horse power appear at the engine shaft. The Brake Horse Power of course is the only power available for doing external work, and is the net power obtained from the Indicated Horse Power after the engine's operating expenses have been paid. The ratio of this output to the input is the mechanical efficiency of the engine. Most constant speed engines of good design have a satisfactory mechanical efficiency. That the variable speed and especially the higher speed engines have an unsatisfactory mechanical efficiency at high speeds is evidenced by test data showing very serious reduction in mechanical efficiency as the speed increases. The writer's attention has been called to one pertinent exception to this characteristic in automobile engines, showing mechanical efficiencies* approximately 90, 86, and 80 per cent at piston speeds of 1000, 1500 and 2100 feet per minute respectively.

The most important factor determining the Mean Effective Pressure is the weight of charge taken into the cylinder. Other contributing factors influencing the Mean Effectible Pressures are:

(1) The absolute pressure in the cylinder during the suction stroke.

In general the closer the suction line comes to the atmos-

*By custom accepted method of determining Mechanical Efficiency of automobile engines (Electric Dynamometer).

pheric line the greater will be the charge taken into the cylinder. If one integrates the area of the loop card below the atmospheric line, a measure of the filling can be obtained and also a measure of the resistance through the fuel mixing device, the manifold and the valves. A more common method of examination along these lines is to determine the distance between the two points of crossing the atmospheric line and call this the filling, after properly referring it to the length of diagram. A further aid along these lines is to determine the manifold depression and compare it with the cylinder depression as determined from the suction line. Considerable care is necessary in taking manifold depression to avoid getting aspiration or dynamic effects.

(2) The Pumping Diagram.

The area of the lower loop represents work performed by the engine in exhausting burned gases and pumping in a fresh charge. Under full load conditions this should be about two pounds per square inch, mean effective pressure, but under less favorable conditions of greater inlet and exhaust resistance may be two or more times this with wide open throttle. This represents from two to five per cent or more of the actual power developed at the piston.

(3) Kind of Gas used.

Different fuels produce a considerable variation in the B. t. u. per cubic foot of mixture and the maximum Mean Effective Pressure that can be obtained.

(4) Homogeneity of Mixture.

The stratification of any mixture may produce a serious loss in power and economy as well as an erratic operating engine in case the stratification varies at any particular load or with varying loads or speeds. The remedy becomes more difficult as the proportions of fuel to air decreases. In the case of gasoline mixtures for example, the proportion of about 1 to 8000 liquid gasoline to air by volume presents often a serious problem.

(5) The position and number of spark plugs in the combustion chamber as well as the spark advance influences the maximum mean effective pressure obtainable. This feature becomes more important as the size of the cylinders increase.

(6) The compression pressure under wide open throttle conditions is usually made all that the particular mixture will

stand without preignition troubles. Stratified mixtures necessitate lower maximum compressions and a lower M. e. p. for this reason. Prevention of stratification in the cylinder is often accompanied by a disappearance of preignition. Higher compression where possible means less clearance volume with less dilution of mixture and lower temperature during the suction stroke. Both of these factors tend towards higher M. e. p.

The determination of the best conditions of the various factors influencing the Mean Effective Pressure will of course produce the greatest Indicated Horse Power for a given cylinder bore and stroke. As previously stated, it is necessary to use as little of the Indicated Horse Power as possible in converting the piston reciprocating motion to the crank shaft rotative motion; in other words, the mechanical efficiency should be as high as possible. The result will be the highest Brake Horse Power developed for a given cylinder bore and stroke. Since the Brake Horse Power is the useful power delivered by an engine, it is the only factor necessary unless one is analyzing the various items enumerated with a view of improving the ultimate result sought.

In analyzing a variable high speed gas engine, one is handicapped in not having an easy method of obtaining dependable indicator diagrams. The Indicated Horse Power of these engines is therefore not generally expressed. In order to determine the indicated horse power a fairly satisfactory method is as follows:

The maximum brake horse power characteristic curve and a curve termed the friction horse power curve are determined. The sum of these two powers at various powers at various speeds is taken as the Indicated Horse Power. The friction horse power curve is plotted from data taken by an electric dynamometer driving the motor at wide open throttle without ignition. Objection to this method of determining the friction horse power are that the pressures in various parts of the engine may be more or less than under regular operating conditions, dependent upon the combination of the working fluid pressures and the inertia pressures. There may be considerable difference also in the power required for the pumping diagram, since there is considerable difference in the weight of the charge

handled, due to its temperature variation from cylinder wall contact and gases left in the combustion chamber from the previous charge. The entire method appears to warrant a careful scrutiny before positive conclusions are based upon data thus obtained.

In order to obtain the M. e. p., net, it is not necessary to find either the I. h. p. or the Mechanical Efficiency.

$$\text{The I. h. p.} = \frac{P\ L\ A\ N}{33000} \qquad (1)$$

where

P = Mean Effective Pressure

L = Stroke in feet

A = Piston area in square inches

N = Number of explosions per minute.

$$\text{The B. h. p.} = \text{I. h. p. x Mechanical Efficiency} \qquad (2)$$

$$= \frac{P\,L\,A\,N}{33000} \text{ x Mechanical Efficiency} \qquad (3)$$

If we have the engine constants and a B. h. p. test we can determine from (3) the value of P x Mechanical Efficiency or the Mean Effective Pressure, net. This represents the portion of the original M. e. p. that finally appears at the engine shaft and represents overall engine power performance. The A. L. A. M. rating has a Mean Effective Pressure, net, of 67.3 pounds per square inch at 1000 feet per minute piston speed. The S. A. E. rating has a Mean Effective Pressure net of 67.3 pounds per square inch at all speeds.

The ability to exceed the S. A E. rating is not difficult in water cooled engines at moderate speeds The excess is 35 or 40 per cent and upwards under these conditions. As the speed increases, however, we always reach a point where the S. A. E. rating can not be equalled. This equilibrium point in piston speed or R. p. m. is useful in comparing the merits of engines along these particular lines.

In order to study a few of the more important power characteristics the writer suggested to Mr. William Patterson and Mr. L. W. A. Bunge of the Mechanical Engineering class of

1915, Armour Institute of Technology, that they select a stationary type, throttle governed engine and observe effects produced by different cams. The general outline was to make one change at a time and keep other factors constant as nearly as possible. The effects of individual factors could then be better understood. Some of the items disclosed by this Thesis investigation are summarized in the following:

The engine was an 8" x 10", 3-cylinder, vertical, 4-cycle type, as shown in the sectional cut, Fig. 1. The inlet valve was in a separate cage in the head close to the front side of the engine. The exhaust valve was in a bay at the rear of the engine. The make and break ignitor was in the head about ⅓ the distance from the inlet valve to exhaust valve. Artificial gas was used in all the tests. and the normal full load speed was 325 R. p. m., or 542 feet per minute piston speed. The power was absorbed by a prony brake and calibrated instruments were used in all the work.

New constant acceleration cams were designed, built and installed. These were designed split so as to facilitate changes The old cams were solid and keyed to the shaft. Fig. 4 represents the method of construction.

The valve setting for the old and new cams were as follows:

TABLE NO. I.

	Old	New
Inlet opens	10°E	0
Inlet closes	20°L	40°L
Exhaust opens	32°E	60°E
Exhaust closes	0	6°L

Curves in Figs. 5, 6, 7, and 8 show valve lift and valve area characteristics. All curves designated "A" refer to the old cams and those designated "B" refer to the new cams.

The valve lift versus crank-pin position diagrams are as indicated in Fig. 5.

The valve area versus crank-pin position diagrams are as indicated in Fig. 6.

Figures 7 and 8 show the valve lift and valve area curves respectively, plotted against per cent of piston travel. The percentages are measured in the direction of the stroke. These two curves show the influence of connecting rod regularity on the lift and port openings as plotted.

The old and new inlet and exhaust valve cam outlines are

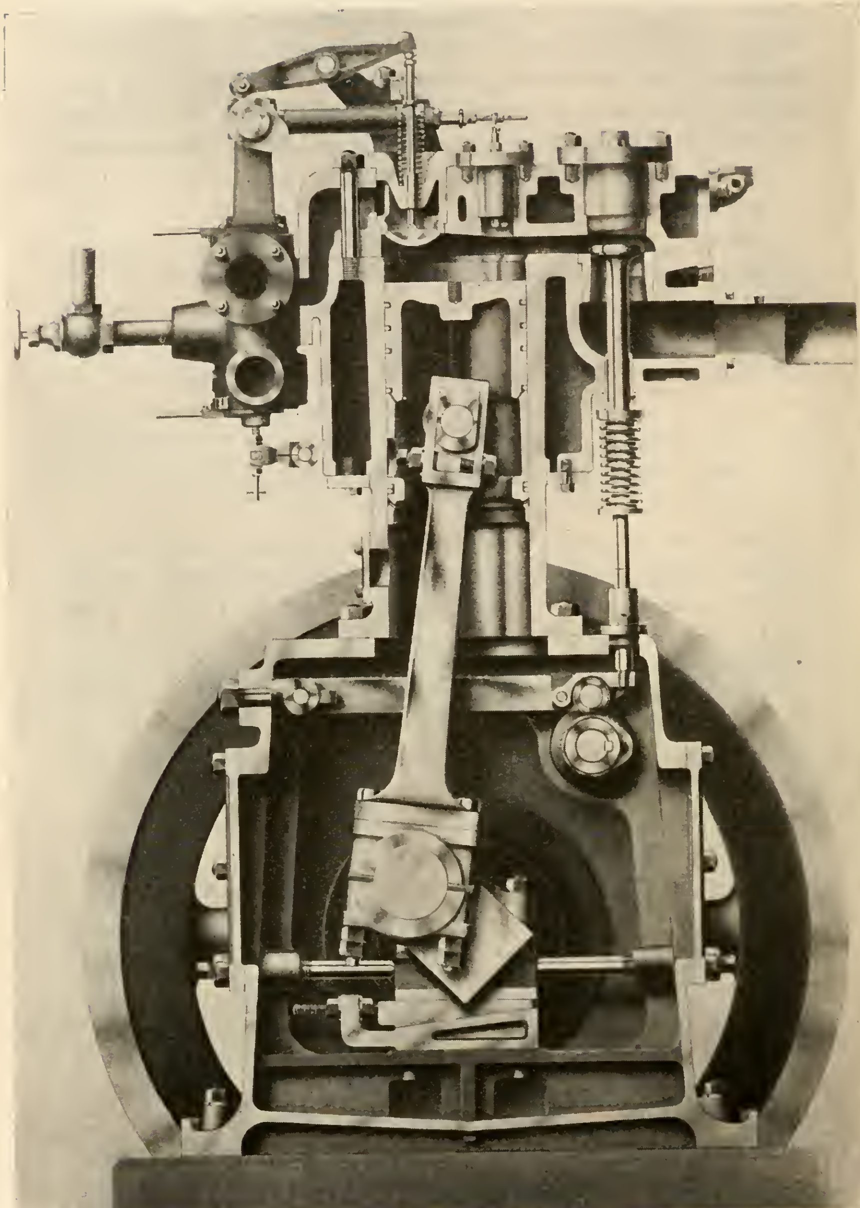


Figure 1

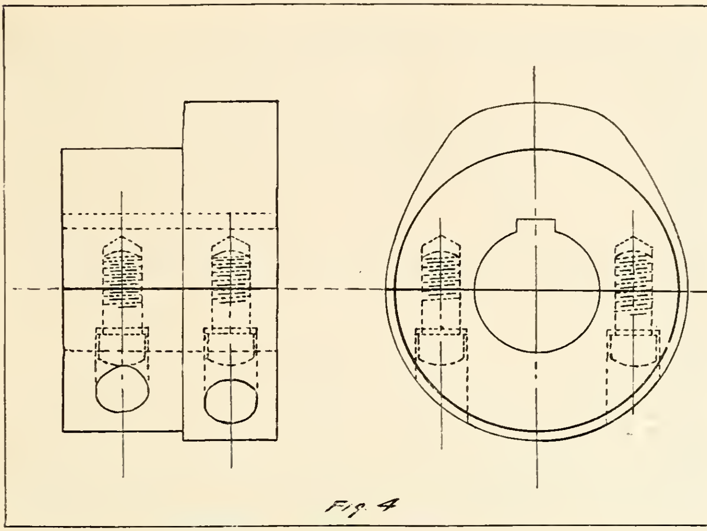


Fig. 4

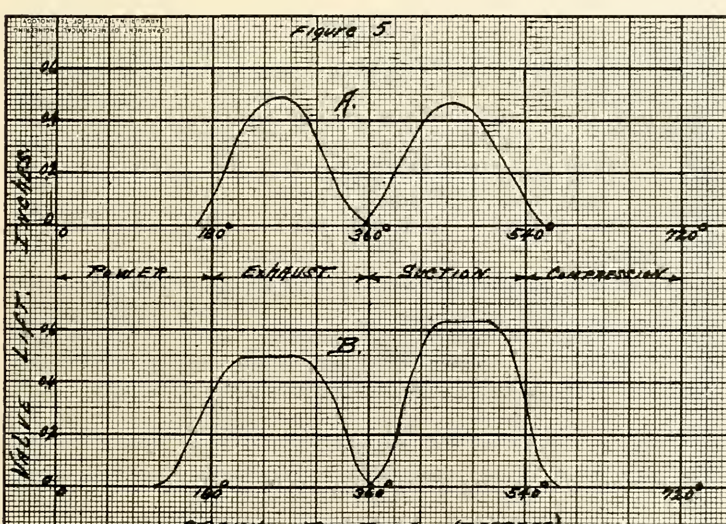


Figure 5
A.
B.
0
180°
360°
540°
720°
POWER
EXHAUST
SUCTION
COMPRESSION
VALVE LIFT INCHES
CRANK POSITION (DEGREES)

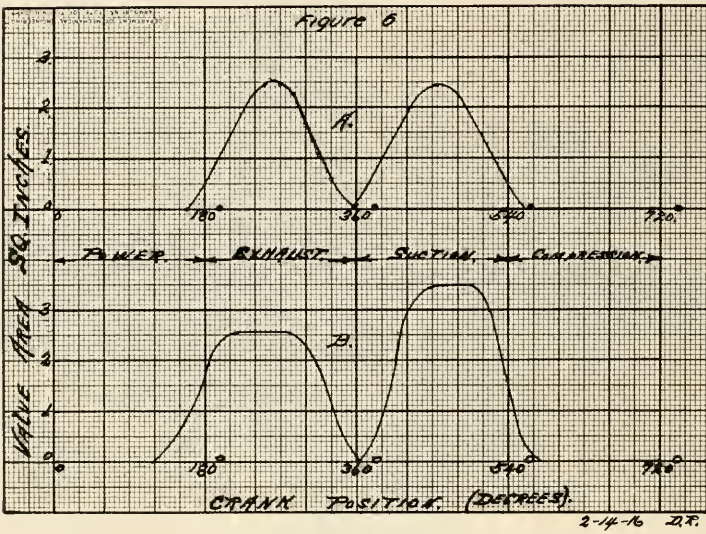


Figure 6
Valve Area Sq. Inches
A.
B.
Power
Exhaust
Suction
Compression
0
180
360
540
720
Crank Position (Degrees).
2-14-16 D.R.

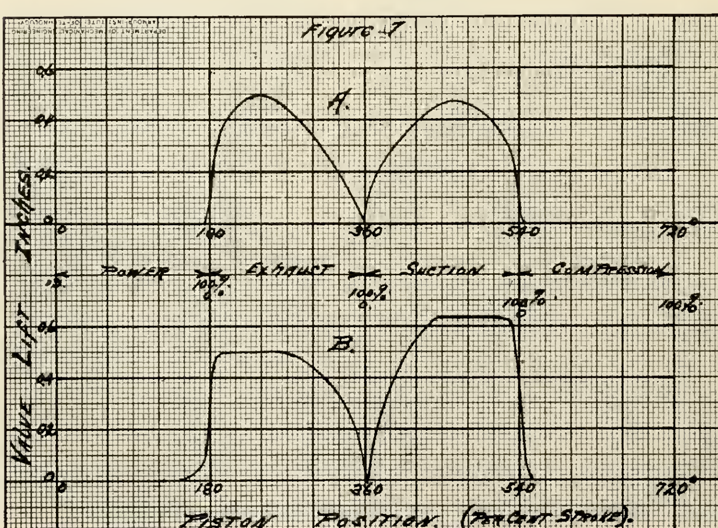


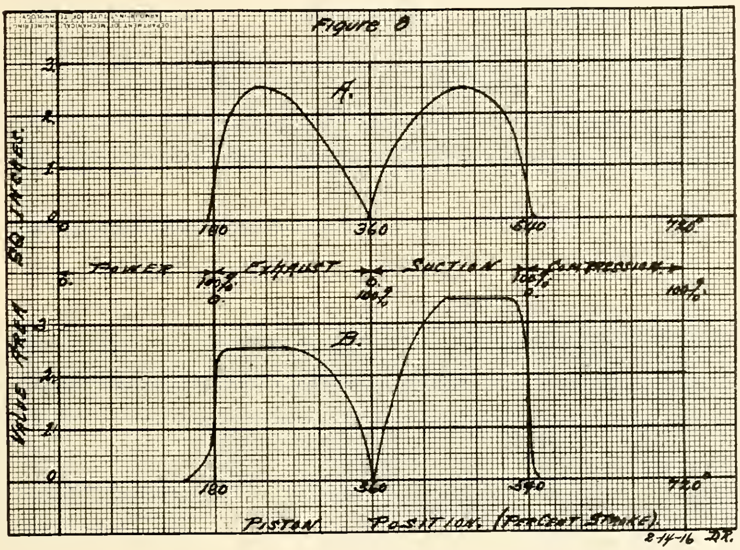
Figure 7
Valve Lift Inches.
A.
B.
Power
Exhaust
Suction
Compression
100%
0
180
360
540
720
Piston Position. (Per Cent Stroke).
2-14-16 D.R.

shown in Figs. 9 and 10, respectively.

Test runs were made at various loads, up to the maximum obtainable, i. e., approximately wide open throttle both before and after the changes.

Figs. 11, 12, 13, 14 and 15 show test results plotted in different ways. The curves designated "1915" show results obtained with the old cams and those curves designated "1916" the results with the new cams.

Fig. 11 shows the various fuel characteristic curves. All gas volumes were reduced to a standard of 62° Fah. and 30 inches of mercury. The net B. t. u. of the gas was slightly



higher in the 1915 tests (2.5 per cent) but no correction was made for this variation. A correction for this difference would make the actual gain greater than indicated. In all of the other efficiency curves, however, account was taken of the actual heat value (by Junker Calorimeter) of the gas during the tests.

Fig. 12 shows the thermal efficiencies for the 1915 and 1916 tests. It will be noted that the highest thermal efficiency is 28.5 per cent on the I. h. p. and 23.5 per cent on the B. h. p.

The mechanical efficiencies are as indicated on curves in Fig. 13.

The customary heat balance for the two test conditions under

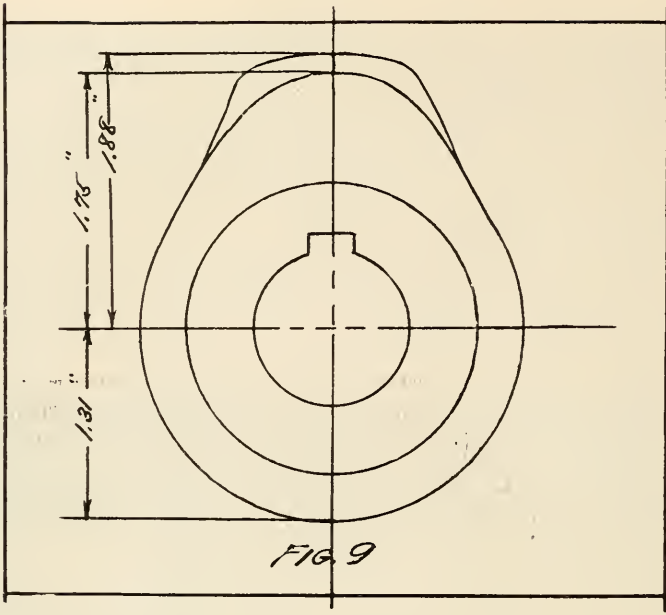


FIG. 9

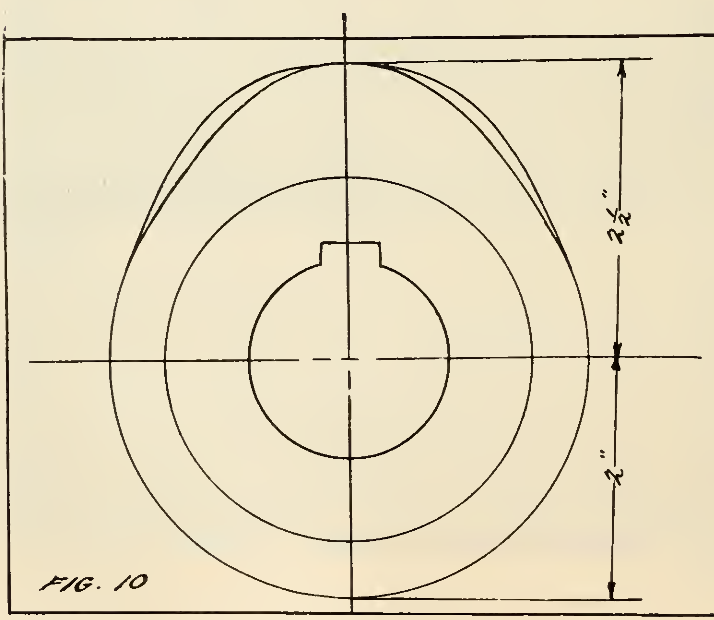


FIG. 10

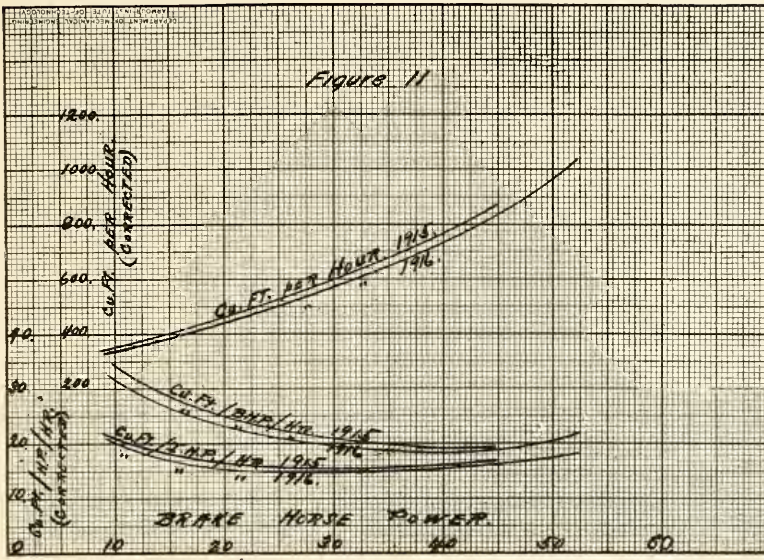


Figure 11
Cu. Ft. per Hour (Corrected)
Cu. Ft. per Hour. 1915.
1916.
Cu. Ft./B.H.P./Hr. 1915
1916
Cu. Ft./I.H.P./Hr. 1915
1916.
Cu. Ft./H.P./Hr. (Corrected)
Brake Horse Power.
1200.
1000.
800.
600.
400.
200
40.
30
20.
10.
0
10
20
30
40
50
60

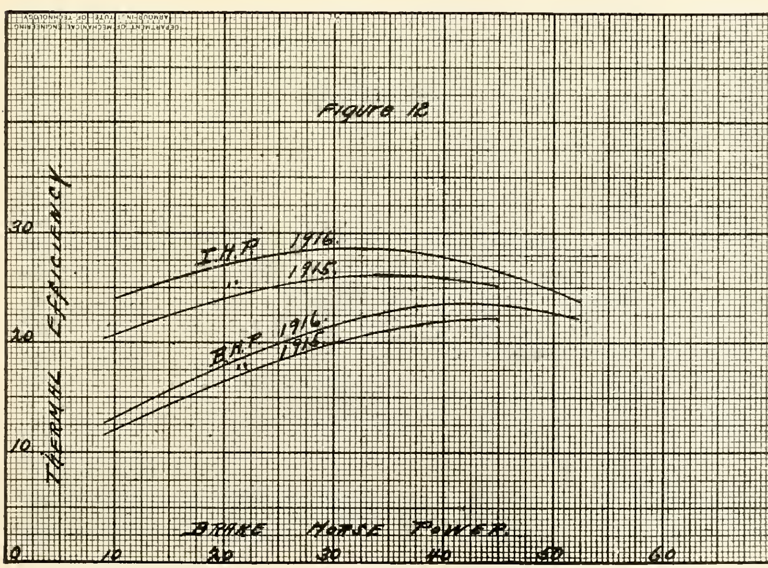


Figure 12
Thermal Efficiency
I.H.P. 1916.
1915.
B.H.P. 1916.
1915.
Brake Horse Power.
30
20
10
0
10
20
30
40
50
60

various loads is shown graphically in Figure 14, with the exception that the I. h. p. percentage equivalent of the total heat supplied is divided into the B. h. p. and the Friction percentage equivalents

The two curves marked "Fuel Distribution to the Exhaust, etc.,", represents the difference between 100 per cent and (1) heat equivalent of the I. h. p. and (2) jacket water loss. It represents:

(1) The sensible heat of the exhaust.
(2) The unburned gases passing out into the exhaust.
(3) Radiation.

From other tests in the laboratories of the Armour Institute of Technology, using a rain type calorimeter to determine the sensible heat of the exhaust, this may range from 40 to 75 per cent of the total "exhaust etc." loss. Unburned gases may vary from zero to 10 per cent or more of the "exhaust etc." loss. The unburned gas loss becomes greater with increased piston speed, lower compression, and poor mixture; i. e., wrong proportioning of total charge or of partial charge (stratification). The procuring of an accurate sample is difficult due to the after burning.

Fig. 15 represents the Mean Effective Pressures of the individual cylinders under various loads with the new cams and shows (neglecting other influences) the stratification of the charge between the three cylinders. The firing order was Left, Center and Right.

As a check on whether or not good filling was being obtained, the suction lines on stop motion cards were examined. The depression below atmospheric in pounds per square inch of this line is shown for various loads in Fig. 16. This represents data taken while the new cams were in use and indicates close to a minimum of resistance through the mixing valve manifold and valves. It is to be noted that the inlet valve lift was increased by the new cams. Mechanical interference prevented similar treatment in the case of the exhaust valves.

Considering the data represented in Figures 15 and 16, a further increase in Mean Effective Pressure would have to be anticipated along other lines than filling, probably by producing a more homogenious mixture. That such a proceeding is war-

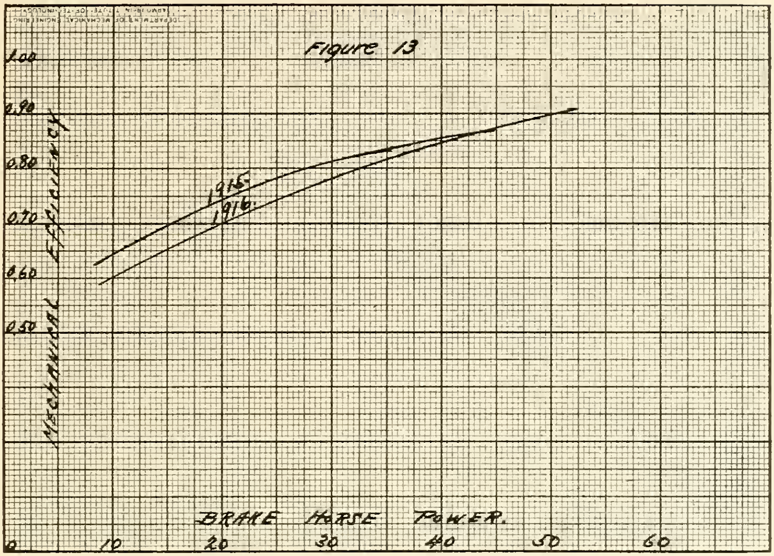


Figure 13
MECHANICAL EFFICIENCY
1.00
0.90
0.80
0.70
0.60
0.50
1915
1916
BRAKE HORSE POWER.
0
10
20
30
40
50
60

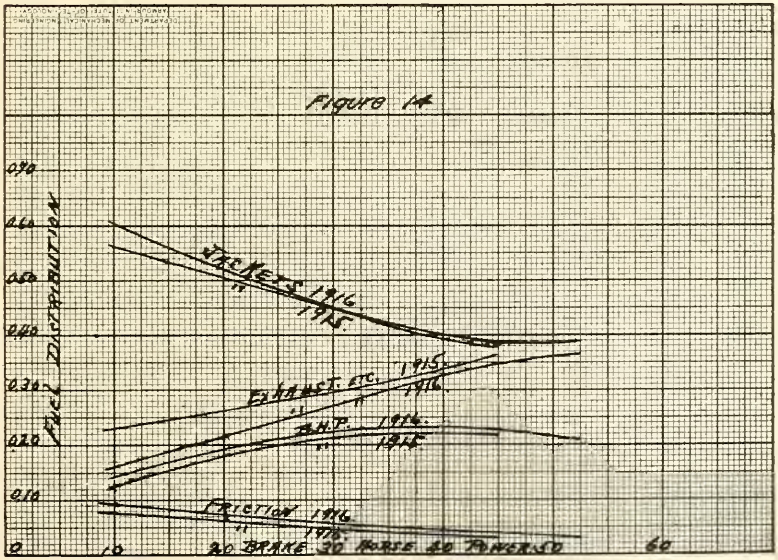


Figure 14
FUEL DISTRIBUTION
0.70
0.60
0.50
0.40
0.30
0.20
0.10
JACKETS 1916
1915
EXHAUST. ETC. 1915
1916
B.H.P. 1916
1915
FRICTION 1916
1915
BRAKE HORSE POWER
0
10
20
30
40
50
60

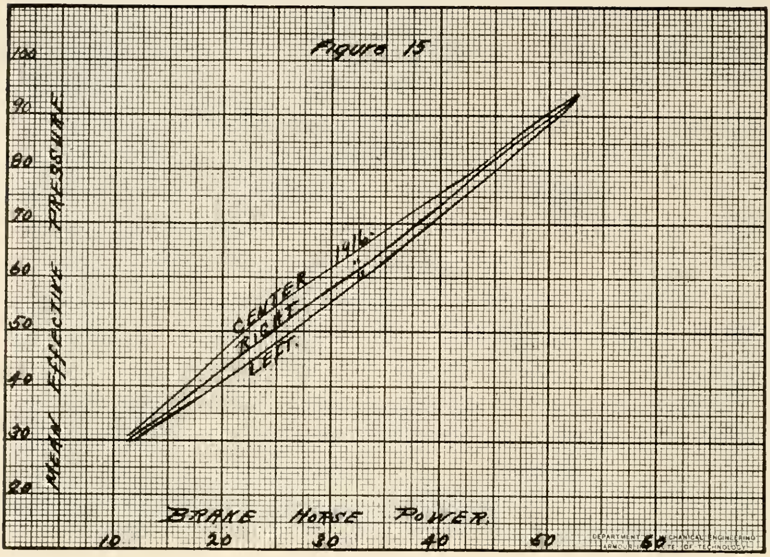


Figure 15
MEAN EFFECTIVE PRESSURE
100
90
80
70
60
50
40
30
20
CENTER
RIGHT
LEFT
1916
BRAKE HORSE POWER.
10
20
30
40
50
60
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY

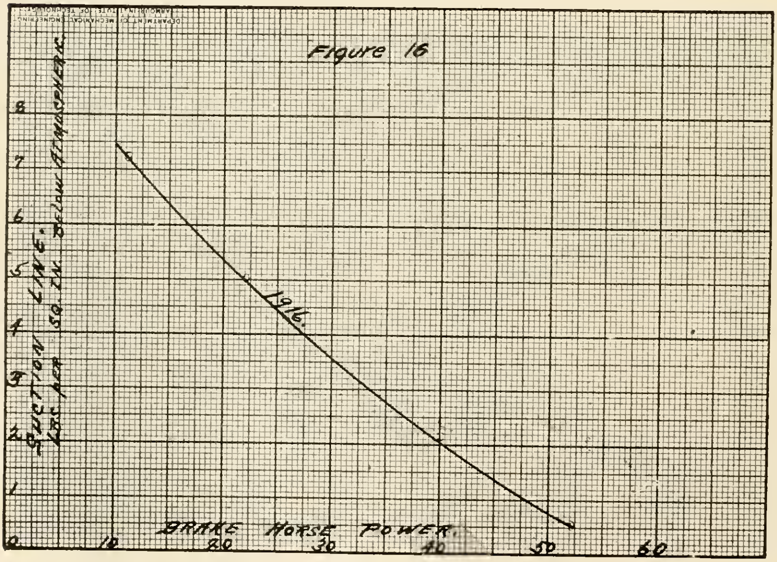
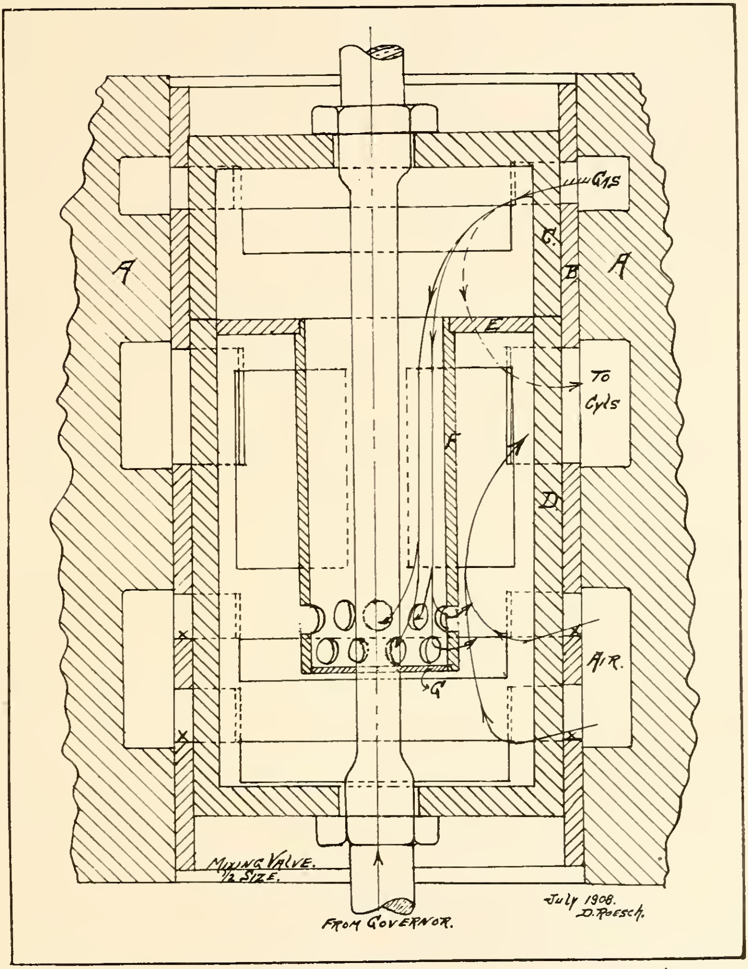


Figure 16
SUCTION LINE.
LBS. PER SQ. IN. Below Atmospheric.
8
7
6
5
4
3
2
1
0
1916.
BRAKE HORSE POWER.
10
20
30
40
50
60

ranted is based upon the experience with a similar mixing device altered as indicated in Fig. 17.

The dotted lines indicate the paths of the gas and air, before the pieces E, F, and G were installed. The gas and air under



these conditions flowed to the cylinder in streams more or less clearly defined. The introduction of part E, F, and G led the gas outlet to a place where it was vigorously scrubbed by the air for the mixture. More intimate mixture was the result and while no test results were obtained, the switchboard readings, gas meter readings and personal observation showed that the power and economy and smoothness of operation were improved.

ILLINOIS ROADS

BY CHARLES W. COLLINS

Sales Engineer, Barrett Manufacturing Co., Chicago, Ill.

With over one hundred and eighty thousand automobiles registered in the State of Illinois in the year 1915 and prospects for an increase of over fifty thousand during 1916; with the horse drawn vehicle remaining about constant; the State ranking third in the United States in expenditure of money for road improvement and maintenance, twenty-third in percentage of improved highways, third in total population and tenth in density of poplation, the people are slowly awakening to the tremendous problem of 'pulling Illinois out of the mud.' Before, however, there is an extensive mileage of improved roads the Public at large, must be educated; shown the advantages derived; and convinced that it will obtain more than value received by road improvement.

The State Highway Department, with its ever increasing corps of engineers is rapidly assuming an important role in the solution of the problem Its existence dates back to 1905, altho it was not until 1913 that the department as it now exists was created. It consists of a commission of three men; a chief State Highway Engineer and an Assistant Chief State Highway Engineer, all appointed by the Governor for a term of six years. The remainder of the employees required to carry on the bulk and detail work are civil service appointees. Briefly the work is divided between five bureaus, namely, the Road, Bridge, Testing, Maintenance and Clerical or Auditing, with a bureau chief in charge of each. It is further divided territorially into seven divisions with a divison engineer over each. The division engineer has a permanent office and field organization which remaintains an independent office and field organization, which reports to the several bureau chiefs in accordance with the subject in hand. Duplications of orders and lack of direct responsibility are eliminated.

In addition, the County Superintendent of Highways who is appointed for a term of six years thru a competitive examination is a deputy member of the State Highway Department. Each township (a district six miles square) has three highway commissioners who are elected at a general election for period of

three years. The law now, however, permits a single commission; this is undoubtedly an advance step.

In round numbers, there are 96,700 miles of road in the state, 16,800 of which are designated as State Aid Roads. The remaining 79,900 miles are under the jurisdiction of the 102 Counties in the State together with the smaller units known as the Townships. The cost of improving the so-called State Aid Roads is shared jointly by the State and County. The amount allotted to each County from the fund appropriated by the General Assembly is proportional to the road and bridge tax levy of the County. For the years 1914-15 and 1915-16 only two million dollars was appropriated. With this present slow rate of improvement the roads built now will be worn out and need rebuilding long before the entire system is completed.

At the January special session of the Legislature a rumor circulated concerning a hundred million dollar State bond issue for road improvement. It seemed to be launched more as a feeler than anything else, but nevertheless, it indicates the trend of public opinion. At present writing two counties (Cook and Vermillion) have already voted bonds totalling three million five hundred thousand dollars and about twenty-five more are seriously considering a like movement. The county is permitted to issue bonds for road improvement equal in amount to 5% of the assessed valuation, less its bonded indebtedness then outstanding. These roads improved comprize the County's State Aid road system and upon completion are turned over to the State and become subject to its recommendation for maintenance. The State's yearly allotment to the county will pay the interest and part of the principal of the bond. The twenty year serial bond issue bearing 4 to 4½% interest is most desirable.

The field of highway engineering is unlimited. It is just in its infancy, not only in Illinois, but in the entire country. We are pioneers in the building of modern roads to cope with and meet the requirements of the modern conveyance. For best results co-operation of all parties involved, engineer, contractor, manufacturer, and the public is essential. As pioneers we are blazing the trail, establishing a precedent so to speak. This is the opportune time for the highway engineer to raise his profession to the level of that of the other learned professions. He

must avoid being too technical, which often tends toward narrow mindedness; overcome his attitude of aloofness toward the public, speak in the layman's own language, mix with him socially, and thus gain his confidence. Kipling's poem entitled "If" with possibly a little trig, calculus, or analyt interpolated should be the mascot of the engineer.

Returning to this mundane sphere, we would say it is the exception rather than the rule to find good road material available locally in the counties of the State. Good farm land and road materials seldom go hand in hand. The prairies of the State enhance the difficulties of the drainage problem. As is well known, the keynote of a good wearing road regardless of type is proper drainage and foundation.

This brings up the type of road to be built. It should first of all be commensurate with the amount of traffic. It is equally inefficient either to build a low cost pavement on a heavy traveled road and attempt to maintain it or to build a high cost road on a lightly traveled road. Each type naturally produces most economical and satisfactory results when placed under conditions best adapted to itself. It is needless to say the favorable fields overlap and result in competition. Climatic conditions, character of subgrade, material available, value of abutting property, character as well as amount of traffic, all have a direct bearing on the type of road built. It must be remembered, however, that the traffic census of an unimproved highway bears but slight relation to that of the same highway improved. The traffic may increase many fold. In this connection we would say that the maximum load and speed of the auto truck (commonly known as the road wrecker) should be regulated by law, and the license based on mileage traveled as well as horse-power of engine.

One must also bear in mind that, provided a low first cost road can stand up under traffic when properly maintained under a patrol system like that of the New England States, when figured over a long period of years, it is generally considerably cheaper than the high first cost road which requires less maintenance during its early life. The interest on the difference on first cost of the two roads will more than pay the extra maintenance of the low cost road. For example a water-bound macadam road costs approximately eight-five cents per square

yard and a brick road on a concrete base one dollar and eighty-five cents. The former road carrying an average of eight hundred vehicles daily can be maintained indefinitely with cold surface applications of refined tar, at a maximum cost of four cents per square yard, per year. Adding together the interest on difference of first cost, maintenance charges, and depreciation for sinking fund on the latter road the cost per unit is considerably higher.

When the traffic exceeds the above amount the surface treated water-bound macadam road gives way to the bituminous macadam (penetration method) or bituminous concrete (mixed method, either open or Topeka mix). Specifications for this or any other standard type of construction are available for distribution to interested parties at the State Highway Department at Springfield. Too much emphasis cannot be laid on the necessity of attention to details of construction, and systematic maintenance of bituminous roads. Due to the lack of this attention in the past many roads have failed, and a tendency developed to build a higher cost road requiring less maintenance during its early life, but in reality less economical and serviceable from a community standpoint. At the present time, however, many road builders are returning to the low cost road properly maintained. The bituminous macadam road costs about one dollar and fifteen cents per square yard. The annual maintenance is directly dependent on traffic the road is subjected to. An average of from two to three cents per square yard is considered a very liberal allowance. These figures although based on records over a period of a decade are a mean only and the extremes are quite variable.

It is true Illinois has not the trap-rock that is available for road building in the New England States, but limestone quarrys producing a fairly hard stone are distributed pretty generally over the state and limestone roads properly built and properly maintained fulfill their purpose quite as well as the trap-rock roads of New England. We would emphasize the axiom that no one type of construction is a "cure all" for Illinois "mud roads."

Co-operation should be our watchword; eliminate the individual's narrow horizon, let all work for a common purpose. Our State would then soon assume its proper position in relation to the other States in road building.

CHARACTERISTICS

BY H. W. NICHOLS

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Many problems, particularly electrical ones, are conveniently investigated by means of the motion of characteristics of the separate elements of the system. By the characteristic of an element is meant the relation between variables determining the operation, for example between the voltage over a circuit element and the current in it: thus if these variables are denoted by v and c, the functional relation $v=f(c)$ is a characteristic of the element, and the curve showing graphically this relation is called a characteristic curve.

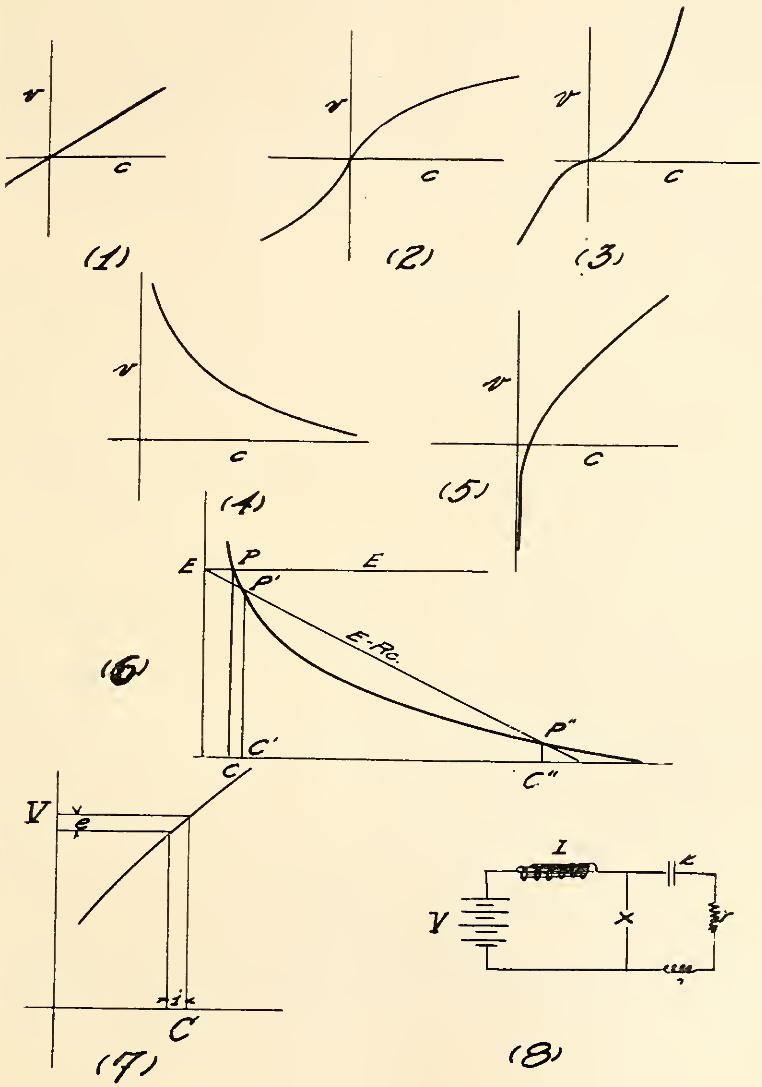
If the operation of the element requires the knowledge of three variables, the characteristic is represented by a surface, and if there are more than three, it cannot be represented in three-dimensional space, but may still be regarded as a surface in hyperspace.

A few of the characteristic curves met in practice are shown in the figures, the simplest being that of figure 1 which is the characteristic of an ideal resistance at constant temperature for which $v=R\ c$, with R constant. If the change in resistance with temperature were taken into account, a surface would be required to represent the relation $v=f(c,T)$ unless the operation was always such as to fix a relation between any two of the variables.

Figure 2 shows a characteristic in which the voltage drop over the element approaches a limiting value, or in which a certain voltage produces a very large current; and figure 3 shows a corresponding saturation value of current.

Figure 4 is representative of arc phenomena, and figure 5 shows unilateral conductivity, such, for example, as occurs in some crystals, lightning arresters, etc.

Characteristics drawn for very slowly varying states may not hold when the state of the system is varying rapidly: the curve representing a succession of equilibrium positions is called the static characteristic, while the other is usually called the dynamic characteristic. When the two differ, the operation of the element is not independent of wave-form, that is, the device pre-


v
c
(1)
v
c
(2)
v
c
(3)
v
c
(4)
v
c
(5)
E
P
E
P'
E-Rc.
(6)
P''
C'
C
C''
V
e
i
C
(7)
L
k
V
x
r
(8)

sents the phenomenon of frequency distortion. The dynamic characteristic often has the form of a closed loop.

The subject of characteristics has been studied somewhat in the last ten years as a field by itself, but it has not received the attention it deserves in engineering text-books; for which reason some elementary features of the subject are discussed here and the reader is referred, for a more detailed treatment, to such books as Barkhausen, "Problem der Schwingingungserzugung" or Busch, "Stabilitat, Labilitat und Pendulungen." References are there given to original sources, principally Simon and Kaufmann.

Equilibrium and Stability of Operation. Consider any network; it may be cut at any pair of terminals and divided into two parts, one of which contains the driving element, and will be called the source, the other the driven element, called the load. Let the characteristic of the former be $v=S(c)$ and of the latter, $v=L(c)$, these being measured from the terminals above mentioned. A problem of first importance is then to determine whether these elements will operate together in equilibrium if it exists.

The condition that the two shall operate together is evidently that $v=S(c)$ and $v=L(c)$, considered as simultaneous equations, shall have a physically possible solution, $v=V$, $c=C$.

To determine the stability of operation at this point, we recall that the stable operation of a system requires that, in any small displacement of the system from the equilibrium position (V, C, in the above case), the reaction of the load to this change shall be greater than the increased driving force of the source. By the usual method of expansion in a Taylor's series, it is found that the analytical condition of stable equilibrium is, that at the point (V, C): $L'(C)$ greater than $S'(C)$.
in which accents denote differentiation with respect to the argument. If the inequality is reversed the operation is unstable at the point in question. When more than two variables are present, analogous conditions may be derived in the same way as for the simplest case.

A very good illustration of the use of these conditions is found in the operation of the arc, Nernst lamp, or similar devices which have falling characteristics such as that of figure

6. Suppose such a load is supplied from a low resistance generator of voltage E, whose characteristic is therefore the horizontal line S(c)=E=constant. The point of equilibrium is at P, but here S'(C)=O and L'(C) is negative, so that the equilibrium is unstable and the device will not operate under this condition. Moreover, this will be the case at all points of the characteristic, so that an arc will not operate with stability from a source of constant voltage.

Now suppose a resistance R is added in series with the generator, so that the new generator characteristic is: S(c)=E—Rc. represented in the figure by the sloping line. This line cuts the characteristic of the load in the two points P' and P": at the first point S' (C)—L')C) and the operation is again unstable but at the second S' (C)—L'(C") and the operation will be stable according to the condition of stability. This reasoning shows why a ballast resistance is necessary in the operation of such devices.

There is a certain limiting value of resistance which will cause the two points P' and P" to coincide when the generator line is tangent to the load characteristic, and a greater resistance than this will cause the arc to go out, because, for the given voltage E, the characteristics will no longer intersect.

Oscillations and Negative Resistance. The most interesting cases are those in which a small variable voltage is impressed upon a system maintained at a definite point (V,C) of its charteristic by the current C, independent of the variable impressed voltage: for example, in figure 7 suppose the impressed voltage e causes the operating point (v,c) to vary slightly about the mean position (V,C) determined by the "polarizing" current C. Examples of such systems are telephone receivers, wireless detectors, rectifiers, and a great many other devices.

Let the characteristic be written c = phi (V). When the additional voltage e is impressed, the resultant current is

$$c = C + i = \text{phi } (V + e) = \text{phi } (V) + e.\ \text{phi}'(V) + \tfrac{1}{2}e.\ \text{phi}''(V) + \ldots\ldots$$

The superposed current i is therefore

$$i = a_1 e + a_2 e^2 + \ldots\ldots$$

where $$a_n = \frac{1\ \text{phi}^n}{n!}(V)$$

We can now find the effects of different characteristics upon the nature of the output current for a given input voltage. Suppose the impressed voltage e is resolved into simple harmonic terms of which a typical one, A(q), has the amplitude A and frequency $q/2_n$. If now all the coefficients a are zero except the first (straight line characteristic in the neighborhood of (V,C)) the output current i(q), corresponding to the component A(q), is simply a copy of the latter. No distortion will appear, and such a characteristic belongs to a simple repeating element.

If all the coefficients except a_2 are zero, the component current due to any A(q) is made up of two parts:

$$i(q) = \tfrac{1}{2}\, a_2 A(O) + \tfrac{1}{2}\, a_2 A(2q)$$

The first part has a constant average value and represents a direct current—the element therefore acts as a rectifier, the rectifying effect being measured by the coefficient a_2. The second part is of double frequency, and the element acts therefore as a frequency changer.

Since a_1 is the slope of the characteristic and a_2 is roughly proportional to the curvature at the point in question, inspection of a given characteristic will indicate its use. Further examination will show that all even order terms introduce rectification while the odd order ones produce only multiplication of frequency, since intregal of:

$$\int_0^1 A(q)^m\, qdt = O \qquad \text{if } m \text{ is odd.}$$

When the impressed voltage is so small that its square may be neglected, the device acts is if its resistance to the voltage v was $1/a_1$, which quantity is therefore sometimes called the alternating current resistance of the element. Since in some elements phi ^{1}(V) may be negative, it follows that the element may behave like a negative resistance, that is, its introduction into an alternating current circuit may decrease the total resistance of that circuit. An arc is such a device. It will be apparent that if the resistance of the circuit to which the element

is added is small, the negative resistance of the element may cancel that of the circuit, so that an alternating current may be maintained without a driving force of the same type. This is the case of free oscillation, and is illustrated in the simple circuit shown in figure 8 in which an arc is shown supplied by the battery V through the very large inductance L, which allows only direct current to pass. The arc is shunted by the resonant circuit containing inductance l, capacity k, and resistance r.

Let C be the current in the battery and i the alternating current in the resonant circuit; also let $V = f(C)$ be the characteristic of the arc. The circuit equation is then, if p represents the operation d/dt:

$$\left(l\,p + r + \frac{1}{k\,p}\right) i + f(C + i) = V$$

that is:

$$\left(l\,p + r + \frac{1}{k\,p} + f^1(C)\right) i = 0$$

This equation can be satisfied by values of current different from zero if and only if

$$k\,l\,p^2 + 1 = 0,$$
$$r = -\,f^1(C).$$

The first of these conditions means that the frequency of the oscillation will be

$$\frac{1}{2^n\sqrt{kl}}$$

and the second that the resistance of the circuit must be decreased until it is equal in absolute value to the slope of the characteristic, while the characteristic itself must be a falling one, since r is necessarily positive. Under these conditions an arc will "sing" and may be used as a generator of oscillations.

ELECTRIC LIGHTING PLANTS IN SMALL VILLAGES

BY G. I. STADEKER

Sales Engineer, Western Electric Co., Chicago, Ill.

The electric light plant for a village of from 450 to 600 people, presents a problem quite different from that usually encountered in designing a lighting plant for a larger town, in that the operating expenses become the all important and determining factor to the exclusion of almost all other considerations. Of course, operating expense plays a very important part in all engineering design, but in lighting plants in large villages and towns, the question becomes the effect of greater or lesser expenses over the profits, whereas in a small plant of the size mentioned above, the question becomes whether or not the plant shall be a financial success or total financial failure.

Such a village generally has from 100 to 125 residences and stores. If 50% of these are ultimately connected to the electric light lines, the limit has practically been reached. The villagers are usually retired farmers who are cautious and slow to make any change which will cost them money and very frugal in the use of the electric light, so that the average bill in the summer months is about $1.50 per meter, running up to $3.00 in the winter. Consequently the income from the residential load is very limited, but this can be supplemented by lighting the streets, which should yield twenty to twenty-five dollars a year for each 100-watt Tungsten lamp burned from dusk to eleven o'clock or midnight. Usually about thirty street lights are required, netting from $600.00 to $700.00 per annum to the plant owner. The total income to the plant will probably be about $1400,00 the first year of operation, increasing to about $1800.00 after a few years. Ultimately the consumers may become educated to the use of heating devices and electric household appliances, but generally with the slow moving farmer's mind to work upon, and the lack of initiative of the owners of these small plants, several years are required before this load can be properly developed so as to affect the revenue.

This gross income is so small that it becomes absolutely im-

perative that operating expenses be kept at a minimum, and first of all prohibits the operation of the generating unit twenty-four hours per day, (which would require two shifts of engineers, at a prohibitive cost) and suggests the use of a storage battery as a means of securing twenty-four hour service. The storage battery adds materially to the initial cost of the installation, but does not increase the overhead charges on the plant by a very considerable amount, whereas a double shift of engineers very materially increases the operating expenses. On the contrary, if twenty-four hour service is not given, it becomes necessary for the consumers to keep their oil lamps for use in dark mornings, and dissatisfaction with the service generally makes it impossible to get more than approximately 30% of the buildings in the town on the lines, thereby materially reducing the income of the plant.

Thus, the economics of the problem eliminate the alternating current system from consideration—unless it is expected that a transmission line will soon be built in the vicinity of the village—and centers the engineering considerations upon a direct current storage battery installation. The only considerations in connection with the problem which might make an alternating current installation advisable, are—

First—That a high tension installation is close enough to make it necessary to consider the possibility of its lines being extended thru the village at some future date.

Second—The probability of the village growing rapidly and outgrowing the limits of economical direct current distribution.

Third—The possibility of a motor load being developed.

The first consideration mentioned above, is of course, variable in each case, and requires special study and investigation. The second and third, however, are rarely met; for these small villages, at least in the middle West, rarely grow at an appreciable rate and rarely have any manufacturing industries. Furthermore, the farthest point of distribution seldom exceeds half a mile from the power plant, so that the majority of plants in villages of the size under consideration, are direct current installations.

The Generating Unit:—Since the development of the crude oil, or distillate engine within recent years, this type of motive power has completely enveloped the field of small plant installations. The generator is usually of from 22 to 30 K. W. capacity, requiring an engine of from 40 to 50 H. P. to drive it, and internal combustion engines of these sizes produce very economical results. The ideal unit consists of a direct connected engine-generator outfit, but this requires a slow speed generator, and since the cost of electrical machinery is inversely proportional to the speed, the cost is materially higher than for a belted outfit. If the initial cost runs up too high, the percentage of the income derivable from the plant which must be charged off to interest on investment and depreciation, becomes so great, that here again the ideal must be sacrificed to the economical considerations and a belted unit selected. When a direct current storage battery system is to be installed, more than one generator need not be considered, for the battery can be relied upon to act as a reserve in case it should become necessary to shut down the generating unit for a couple of days for repairs. In alternating current installations, however, it is advisable to install two units, as, for instance, a 22 K. W. and a 12 K. W., and both generators should be equipped with amortissuer windings to assist in parallel operation. An alternating current generator is rarely a source of trouble, and frequently when funds are limited at the time of the initial installation, a single 30 KVA alternator is belted to a 25 H. P. engine, and this unit is relied upon to carry the load for the first few months of operation. When the load has developed to the point that the 25 H. P. engine can no longer carry it, an additional 25 H. P. engine is coupled direct to the first engine, and then a total output of 50 H. P. is available to drive the alternator. During off-peak load, the engines are uncoupled and only one operated, thus securing good economy by operating the single unit at its full load. If one engine is down for repairs, the other acts as a reserve to handle at least the most important part of the load.

System of Distribution:—The 110/220-volt, three-wire sys-

tem of distribution, is most economical in copper, and the generator should be designed for this service. Except in the business section of the town, which is only a few blocks long, the distributing lines to each block are two-wire, 110-volt tapped off the main three-wire feeders at the street intersections, and connected in such a way that the load will be balanced on the three-wire system. This varies from city practice, where the three-wire lines are all brought into the junction box in each residence, but in a village is more economical in copper than the three-wire system, for the load constituted by a block of three or four houses in a village is so light, that two No. 8 wires can carry the current required by a 110-volt distribution. And, since a No. 8 wire is the smallest which should be strung on the poles, for mechanical reasons, it is a waste of copper to add a third wire of the same size.

The distributing lines can be built of 25′ scant 6″ top poles, except at railroad crossings, where the state laws usually require that the poles be stepped up to forty feet. Generally about 125 poles are required. The line hardware should be galvanized and the poles guyed at all corners and dead ends. Lightning arresters should be placed at two or three centers of distribution, and also at the power house.

Street Lights:—The street lights should be controlled by a separate single pole switch at the power plant, which is tied in on the positive bus, and the street lights connected between the single feeder and the neutral wire, thereby permitting the use of 110-volt lamps, which are cheaper than 220-volt lamps, and requiring only one additional wire on the poles. Either a 60-watt standard Tungsten or 100 C. P., nitrogen filled lamp should be placed at each street intersection, (usually 300 feet apart) and hung in center span street hoods, which place the source of illumination out in the middle of the street, away from the trees, and result in ample light to meet the requirements.

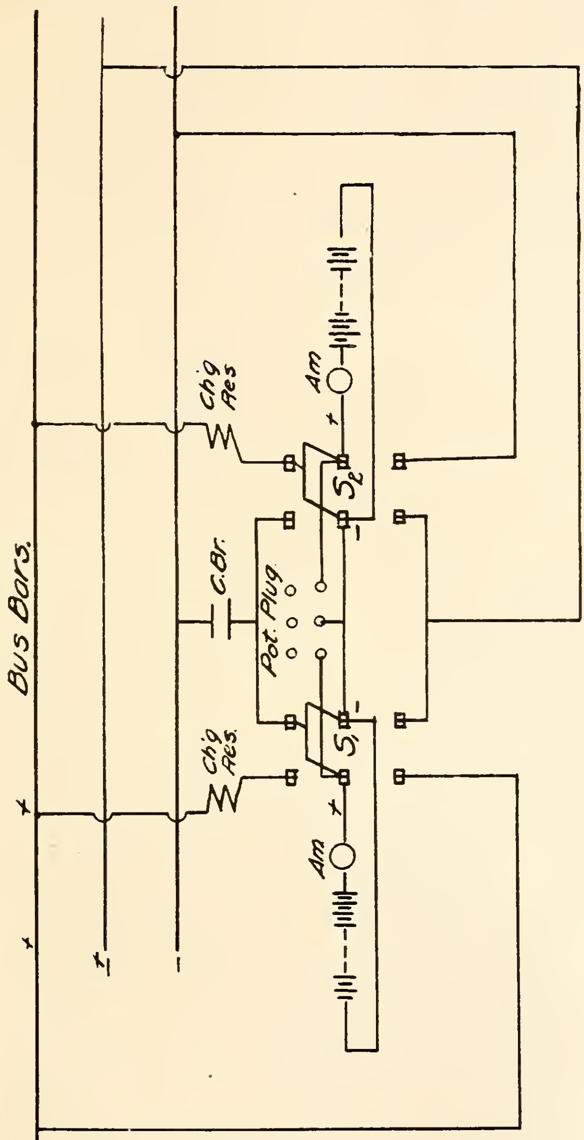
The Storage Battery:—The size of the storage battery is usually determined by the money available for the initial installation. The smallest equipment which should be installed is an 80-ampere hour, 232-volt battery, but after the day load has been developed, a 200-ampere hour battery may be required, though seldom larger than this. For the initial installation a

120-ampere hour battery is recommended, usually consisting of seven plates per jar, in jars large enough to permit the addition of four more plates if required at a future date, thus bringing the ultimate capacity of the battery up to 200-ampere hour. The battery requires approximately 2-1/2-volts per cell to finish the charge, and since the generator can only develop 250-volts, and a higher voltage would burn out any lamps which might be turned on while the battery is being charged, the simplest practice is to divide the battery in two halves during the charging and connect each half in series with a charging resistance across the 220-volt bus. When the battery is fully charged, both halves are connected in series and floated across the line with the middle point tied to the neutral. Fig. (1) is a schematic diagram of this connection, which can be accomplished by two D. P. D. T. switches. A reverse current, or underload breaker is connected between the generator and battery to prevent the battery from discharging back into the generator, and running it as a motor when the engine is stopped. Lead batteries are recommended for this service, although the Edison battery is sometimes used, but the initial cost is 50% greater than the lead battery, and the advantages gained by its installation in a stationary plant, where weight per unit of output is not a consideration, does not warrant the additional expense.

The Switchboard:—To meet the requirements of the Board of Underwriters', a double pole overload circuit breaker should be installed in the main generator circuit, but this is frequently omitted and enclosed fuses substituted. Two ammeters, one on each outside leg of the lines should be installed .and also one in the battery circuit, and a volt meter with proper receptacles and plug, so it can be used to read both line and battery voltages should be placed on the generator panel.

Cost Estimates:—Average figures for use in estimating the cost of line material, are as follows:

25′ scant 6″ poles	$1.75 ea.
3′ 2 pin cross arms with necessary braces, bolts, pins and insulators	.60 ea.
4′ 4 pin ditto	.70 ea.



SCHEMATIC DIAGRAM
BATTERY PANEL

Note: Throw switches S_1 and S_2 up for charging - down for discharg.

FIG. I

6' 6 pin ditto .... 1.05 ea.
Anchors with guy wire, rods and clamps. 1.50 ea.
Single pole lightning arresters .... 3.50 ea.
Street hoods with guy wire, clamps, pulleys, chain and lock .... 3.00 ea.
Copper—from 4000 to 6000 lbs. at base price.

The approximate initial cost of a plant as described above is as follows:

30 K. W. 125/250-volt belted generator. $ 450.00
50 H. P. engine with storage tank 1800.00
Switchboard, generator, battery and feeder panel 400.00
Battery—120-ampere hour 1700.00
Power house 500.00
Line material (dependent upon price of copper) .... 1500.00 to $1800.
Labor of complete installation 500.00

Total $6350.00 to $6650.00

Operating Expenses:—The cost of fuel per annum for a direct current storage battery installation, runs higher than an alternating current "night service only" installation, for of course, additional energy must be supplied for charging the storage battery. In two installations, of 50 H.P. engines driving 30 K. W. generators in conjunction with storage batteries, the cost of fuel the first year of operation averaged $475.00. The cost of fuel for a 50 H. P. alternating current "night service only" installation, was only $200.00, but this low value was probably due to the fact that the residence load was not highly developed, and under normal conditions it should approach $300.00. The cost of oil and waste runs to about $100.00 per year, and water to $30.00 per year. The other charges against the plant are the wages of the Engineer, which amount to $600.00 or $700.00 per year; the interest on the investment at 6%, and taxes and insurance at 21-/2%. The total operating and overhead expenses are so high that a plant of the size described does not often offer an attractive proposition from the financial standpoint, and consequently a large number of them are under municipal ownership.

WATER POWERS OF SOUTHEASTERN ALASKA

BY LEONARD LUNDGREN

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In the November issue Mr. Lundgren described the various districts covered by his reconnoissance of the Water Powers of Southeastern Alaska. In this article and which will be concluded in next issue, a detailed description of the various water power projects is given in the order of their geographical location from south to north.—The Editors.

THE KETCHIKAN REGION

General

The Ketchikan region is the southermost mining district in Alaska. It is limited on the east by British Columbia, on the south by Dixon Entrance, on the west by the Pacific Ocean and on the north by Sumner Strait and Ernest Sound. It contains the Prince of Wales, Revillagigedo and adjacent islands and the mainland to the east. The total land area is 9,370 square miles.

The mountains rise abruptly to an elevation of from two to five thousand feet, and the peaks farther inland to elevations of six to ten thousand feet. Peninsulas and islands adjacent to the mainland are separated by deep, narrow fiords extending many miles inland. Cleveland Peninsula, the largest of these promontories, is ten to fifteen miles wide and contains mountains whose summits reach over four thousand feet in elevation. The descent of the valleys is steep, resulting in beautiful waterfalls of considerable volume during the flood season. The principal rivers are the Unuk and Chickamin.

The seaward extension of many of the valleys is represented by tidewater channels, the largest of which is the Portland Canal, which extends inland 150 miles with a northeasterly course. It is only a mile or two in width and is enclosed by mountains that rise abruptly to elevations of four to six thousand feet Bear and Salmon rivers enter at the head of this canal.

No general topographical maps of the Prince of Wales or the Revillagigedo Islands are available, and little is known in detail beyond their coast lines, a large portion of which has been

carefully mapped by the Coast and Geodetis Survey.

The Prince of Wales Island is 130 miles long and 30 miles wide. It is separated from the mainland by Clarence Strait, a deep channel about four miles wide, running north and south. Viewed at a distance the island presents a mountainous mass of very irregular outline. Inland lakes are found in low-lying valleys and in basins at altitudes of one thousand feet or more. Two small portions of this area have been surveyed by the Geological Survey, one covering the Kasaan Peninsula, and the other Copper Mountain and vicinity.

Revillagigedo Island is separated from the mainland by Behm Canal, a narrow, steep-sided fiord, which surrounds it on three sides. The mountains range from 2,000 to 4,000 feet in elevation above sea level. George and Carroll Inlets and Thorn Arm dissect this island and are bordered by narrow promontories whose maximum elevation is 3,000 feet.

Ketchikan is located on the southern shore of the Revillagigedo Island, and the sheltered waters of Tongass Narrows make an ideal harbor. Its importance is due to its strategic location as a distributing and collecting center for numerous canneries, mines and small lumber mills and to its being the southermost port of Alaska.

DEVELOPED WATER POWERS

The *Citizens Light, Power and Water Company* furnishes all of the light and power consumed in Ketchikan except that used by the New England Fish Company. The power plant is located on the outskirts of the town, on Ketchikan Creek. Storage is secured a few miles from Ketchikan by low timber crib dams across the outlets of two lakes and by a tunnel piercing the natural dam of bed rock at the outlet of the lower lake. A wood stave conduit is directly connected to the tunnel, making a static head of 225 feet available at the power house. This is a well designed concrete structure with a wood roof supported by steel trusses. Two 1000 hp. Morgan-Smith turbines and two Westinghouse generators, AC, 600 kva., 2300 volts, are installed direct connected.

Mr. Watson J. Hills, of Juneau, initiated the water right on Ketchikan Creek and transferred it on March 6, 1902, to the

Ketchikan Power Co., which completed a small power house that year, having 400 feet of flume, 25 foot head, and a generator capacity of 50 kw. On account of poor service a franchise was granted on April 20, 1903, to the Citizens Light, Power and Water Company, which constructed a flume 1100 feet in length, making a head of 56 feet available at the power house. The machinery consisted of a 200 hp. turbine directly connected to a 60 kw. generator. Operation was prevented by an injunction secured by the Ketchikan Power Co. This was settled by a purchase of the old plant and water rights on December 21, 1903. Because of poor construction and lack of head this second development was unsatisfactory, and in 1906 a new plant, having a flume 3300 feet in length, made available a head of 106 feet. A 240 hp. turbine directly connected to a 120 kw. generator was installed. Anchor ice caused considerable trouble in this plant, and the company, compelled by demands for better service, built the above described plant. The first unit was placed in operation December 1, 1912, and the second unit January 1, 1914.

The *New England Fish Company* is organized under the laws of the State of Maine to engage in the catching and sale of Pacific Ocean fish. The main office is in Boston and the Alaska office is in Ketchikan. This company completed in 1909 one of the largest fish freezing plants in North America on Tongass Narrows about one-half mile southeast of Ketchikan. One hundred thousand pounds can be handled daily and six million pounds of frozen fiish can be stored.

The hydro-electric plant is located on George Arm about four and one-half miles east from Ketchikan in a straight line and about nine miles by steamer. Water is stored in Lake Whitman by a 20-ft. dam across the outlet, which insures a sufficient supply of water during the winter season The wood stave pipe has an average diameter of 36 inches and is approximately one-half mile in length. The power house is a one-story frame building on concrete foundations.

As constant refrigeration is essential and the plant is isolated, two distinct power units have been installed, as insurance in case of accident. Each unit consists of an 1100 hp. turbine direct connected to an Allis-Chambers generator, 6600 volt, 52.7 amperes per terminal, 3-phase, 60 cycle, 600 rpm. Power is

transmitted at the same voltage. Recently this company and the Citizens L. P. & W. Co. have connected their circuits to give mutual service in case of breakdown.

The *Beaver Falls Power Company* is owned by P. W. Silvis, who operates a small shingle mill at the mouth of Beaver Creek which flows into George Inlet about ten miles northeast of Ketchikan. Water is diverted from Beaver Creek by a timber crib dam directly into a wood flume 200 feet in length. Two conduits take out from this flume, one is 800 feet long of 24" riveted iron pipe and supplies water to a 15 hp. wheel in the cannery of the George Inlet Packing Company, also for domestic purposes. The other is of 14" wood pipe 375 feet long, supplying water to an 85 hp. wheel in the aforesaid shingle mill of Mr. Silvis. The static head available at both points of use is 146 feet.

The *Alaska Industrial Company* is operating two small water power plants in connection wtih its mining business on Prince of Wales Island One plant developing 150 hp. is situated on the beach northwest of Copper Mountain to operate the Jumbo Mine about five miles north of Coppermount. The source of supply is Jumbo Creek and a head of 330 feet is secured. Electric power is transmitted at a voltage of 2300 to the motors in the mine. The local office of this company is at Sulzer 40 miles southwesterly from Ketchikan and ten miles north of Coppermount. A 5 hp. plant constructed in 1905 furnishes all the light and power required. A flume and pipe line 2500 feet long conduct the water from Beaver Creek to the wheel.

The *Alaska Pacific Fisheries* owns a cannery located at Chomly on Cholmondeley Sound, Prince of Wales Island, 25 miles southwesterly from Ketchikan. It is operated only through the fishing season. A small water plant furnishes the water required for domestic purposes and the power to operate the machinery. A timber crib dam 8 feet in height and 45 feet long faced with two thicknesses of 2" plank diverts water from a small creek into a riveted iron pipe 3500 feet long ranging in diameter from 22" to 15". Water is delivered under a static head of 160 feet to three small pelton wheels. An .18" wheel operates the turning lathes and other equipment in the machine

shop, a 24" wheel operates the canning machinery and a 36" wheel operates a DC generator, 10 kw., 150 volts, 87 amperes, 1050 rpm.

The *Rogers Mine* is located two and one-quarter miles southwest of Hollis, Prince of Wales Island. Hollis is situated on Twelve Mile Arm forty-five miles westerly from Ketchikan. Water power operates a five-stamp mill and is used for other incidental purposes around the mine. The source of supply is from Harris Creek, from which the water is conducted by a wood flume to the power house, where two 38 hp. and one 25 hp. wheels are installed.

The *Alaska Venture Syndicate* owns and operates the Old Glory Mine on Smuggler Cove twenty-two miles northwest of Ketchikan. A 150 hp. water power plant furnishes power to operate an air compressor.

The Northwest Fisheries Company owns and operates a salmon cannery and a small saw mill at Shakan, Kosciusko Island, at the head of Shakan Bay, a branch of Sumner Strait. Water is conducted from Shakan Creek to the wheels in the cannery and saw mill by a 14" pipe 1000 feet long. Five water wheels are said to be installed operating under a static head of 150 feet having a maximum capacity of 175 hp.

The *United States Salmon Hatchery* is located on Yes Bay forty miles north of Ketchikan in a straight line and forty-five miles by steamer. A flume 3000 feet in length, three feet wide and eighteen inches deep, supplies water for the various requirements of the hatchery. A head of 13 feet is available and a portion of the supply is used for operating a 10 hp. McCormack turbine. This operates a 5 kw. Westinghouse generator.

The *Point Warde Packing Company* is located at Point Warde sixty miles north of Ketchikan in a straight line and seventy-five miles by steamer. A 16" wood stave pipe 700 feet in length gives a static head of 100 feet at the cannery. Three wheels are installed. A 36" wheel drives the fish canning machinery, another 36" wheel drives a 14 kw. generator for lighting purposes, and a 24" wheel drives the fish elevator. These wheels are seldom driven at the same time.

The *Northwestern Fisheries Company* has a cannery at Santa Anna forty-five miles northwest of Ketchikan in a straight line

and sixty-five miles by steamer. A steel pipe 760 feet in length reducing from ten to six inches in diameter supplies the water for domestic use and power. This supply is sufficient for do-

Totem Poles in Alaska.

mestic purposes during the dry season, and power is generated during the wet season only. Three Pelton wheels are installed.

One 24″ wheel is used to run the can making machinery, one 24" wheel is used to run a 10 kw. DC Westinghouse generator for lighting and general power purposes, and a 16″ wheel is used to run the fish elevator. Steam auxiliaries are used during the dry season.

The *Alaska Packers Association* own and operate the Fortmann Salmon Hatchery near Loring, Alaska, which is eighteen miles north of Ketchikan in a straight line and twenty-five miles by steamer. A flume 1600 feet long, three feet wide and eighteen inches deep supplies the water required at the hatchery. A head of 32 feet is developed and a portion of the supply is utilized to operate a 13″ turbine, which is operated for lighting purposes.

The *Hidden Inlet Canning Company* is located at Hidden Inlet, a branch of the Portland Canal, sixty miles southeast of Ketchikan in a straight line and eighty-five miles by steamer. A small pipe line one and one-half miles in length delivers all the water that is available in this vicinity to the canal for domestic use and for power purposes. 2 hp. only is available a part of the time, and a gas engine supplies the necessary power during the low flow season.

The *Alaska Fish Company* owns a cannery at Waterfall on the west coast of Prince of Wales Island sixty-five miles west of Ketchikan in a straight line and one hundred and forty miles by steamer. A small pipe line delivers the supply for washing and power purposes. About 10 hp. is installed.

The *Klawak Cannery Company* operates a cannery at Klawak on the west coast of Prince of Wales Island sixty miles northwest of Ketchikan in a straight line and one hundred and seventy miles by teamer. A small water supply system furnishes water for washing purposes and for developing approximately 10 hp.

The *Irving Packing Company* operates a small cannery at Karheen on the west coast of Tuxekan Island, a small island lying off the west coast of Prince of Wales Island, seventy-five miles northwest of Ketchikan in a straight line and one hundred seventy miles by steamer. A flume 400 feet in length, two feet wide and one foot deep diverts water from Karheen Lake and

furnishes the water supply to the Indian village and cannery. The lower end of the flume is only eight feet above high tide. From this a short flume is used to operate a home-made water wheel. This operates an air compressor and a 2 kw. generator 110 volt. The wheel operates either the air compressor or the generator. Electric power is used for lighting purposes only.

A. J. Dunton operates a small shingle mill in Ketchikan by water power. A small flume diverts water just above the lower rapids in Ketchikan and an effective head of 20 feet is secured to operate a 50 hp. water wheel which operates the plant.

The *Alaska Copper Company* constructed a melter at Coppermount forty miles southwesterly from Ketchikan. Power was secured by diverting water from Reynolds Creek through an 18″ riveted iron pipe to operate various water wheels in the smelter. This mine was closed in October, 1906, and the power plant was found to be valueless when examined during the summer of 1914.

The *Sea Level Mine* located on Thern Arm 17 miles northeast of Ketchikan at one time operated a 30-stamp mill. A crib dam faced with poles, ten feet in height, diverted the water from Gokatchin Creek into flume 200 feet long, and then into a 26″ riveted iron pipe 2500 feet long, which delivered the water to wheels located in various parts of the mill This mine has not been worked since 1903, and the improvements are now practically worthless.

The *Indians of Metlakatla* under the instruction of a missionary named William Duncan operated a small saw mill and cannery on a community basis. Water wheels aggregating a rated capactiy of 50 hp. were installed. Dissension among those interested has caused the shut-down of these projects for a number of years.

The *Alaska Gold Standard Mining Company* constructed a small water power plant to operate a five-stamp mill on Helm Bay twenty-five miles northwest of Ketchikan. This plant has been shut down since 1907.

The *Puyallup Mine* has made a 25 hp. water power development on Maybeso Creek, a short distance north of Hollis. The mine has not been worked during recent years.

UNDEVELOPED WATER POWERS

The Fish Creek Project is located at the head of Thorne Arm, about seventeen miles northeasterly of Ketchikan in a straight line and twenty-five miles by steamer. A good site for a steamer landing is available. On this drainage a lake having an area said to be 500 acres and a surface elevation of 260 feet above high tide is located about one mile from tidewater. Other lakes higher on the watershed may be used for securing additional storage. From the preliminary figures now available it

Gage Near Outlet of Lorver Lake, Fish Creek Project.

has been estimated that the minimum power at this site is approximately 2000 hp. During years of large runoff 6000 continuous horsepower may be generated. Additional stream flow data are now being secured by the Government on this site.

Shrimp Bay project is located at the head of Shrimp Bay, an arm of Behm Canal, about thirty-five miles north of Ketchikan in a traight line and fifty miles by steamer Orchard Lake, about one-third of a mile from tidewater, has an area said to be 2000 acre and an elevation of 134 feet above high tide. A preliminary estimate indicates that a minimum output of 1500

hp. may be secured, which may be increased during normal years to 3000 hp. Stream flow data are now being collected by the Forest Service in co-operation with the Geological Survey, which will permit more final figures.

The Bailey Bay Proect is located at the head of Bailey Bay forty-five miles north of Ketchikan in a straight line and fifty miles by steamer. A lake having an elevation of 345 feet above high tide and an area of 360 acres is located a half mile from tidewater. Bed rock is exposed at the outlet of the lake and offers a good foundation for a dam. The only objectionable feature would be the great length of the dam that is necessary. Preliminary figures indicate that a minimum capacity of 1500 hp. may be developed, which may be increased to 2500 hp. during years of large runoff. The Government is now securing stream flow data so that more accurate information can be given.

The Karta Power Project is located at the head of Karta Bay forty miles northwest of Ketchikan in a straight line and forty-five miles by steamer. Two lakes said to have a total area of approximately 3000 acres have an elevation of 180 feet above sea level. A dam thirty feet in height would provide storage of more than 100,000 acre feet. This would probably be sufficient to entirely equalize the runoff of years below the normal. Preliminary estimates indicate that approximately 6000 continuous horsepower may be generated during years of less than normal flow conditions. A stream gaging station is being maintained by the Government in order that more definite data will be available.

The Coppermount Project is located forty miles southwesterly from Ketchikan at the head of Copper Harbor, a branch of Hetta Inlet. The site was partially developed by the Alaska Copper Company, which plant has been described hereinbefore. Referring to topographic sheet No. 540-B, published by the Geological Survey, the complete topography of the Reynolds Creek watershed may be seen at a glance. The possibilities of equalizing the stream flow of this drainage above Lake Mellen seem very promising and, as the elevation of the present lake level is 876 feet above high tide, it is roughly estimated that 4,000 to 5,000 hp. is available. An additional supply could be secured by driving a tunnel through the divide and thereby diverting the water stored in Lake Josephine.

The Beaver Creek Project is located on George Inlet about ten miles northeast of Ketchikan. A small portion of the power that is available is being utilized by the Beaver Falls Power Company, previously described in this report. About one mile from the shore a lake is located having an altitude of approximately 830 feet. Above this lake is still another lake at an elevation of 1220 feet, which is said to be approximately two miles in length. Nothing is known regarding the area nor the quantity of stream flow but further information might show that the site possesses large power possibilities.

The Carroll Inlet Project is located near the head of Carroll Inlet twenty miles northeast of Ketchikan in a straight line and thirty miles by steamer. A lake having an area of 340 acres is located one and one-half miles from Carroll Inlet 260 feet above the high tide. It is understood that a dam 100 feet in height can be constructed with a crest of 500 feet. A rough estimate indicates that 5,000 hp. may be available.

THE WRANGELL REGION.

The Wrangell Region is situated immediately north of the Ketchikan Region. It is bounded on the east by British Columbia, on the south by Sumner Strait and Ernest Sound, on the west by Chatham Strait, and on the north by Frederick Sound, and comprises Kupreanof, Kuiu and the adjacent islands and the mainland immediately to the east of these islands. The total land area is 5,130 square miles.

Little is known regarding Kupreanof Island. On its north end are two small mountain ranges. One, northeast of Kaka, has summits over 2,000 feet high, and the other, the Bohemian Range, just west of Portage Bay, has peaks 2,500 feet in elevation. The south end of the island consists of low-lying hills, rarely exceeding 1,000 feet in elevation. A low pass from the head of Duncan Canal to Portage Bay nearly divides the eastern and western parts of the island. Kuiu Island is separated from Kupreanof Island by Keku Strait, an irregular passage open only to small boats. It is deeply dissected by bays, giving an extremely irregular shore line.

The distance from salt water to the divide of the coast range narrows down in this district, consequently the mainland streams are of lesser importance. The glaciers frequently fill


Mill Creek Cascade near Wrangell, Alaska
J.R. Worden

the valleys down to tidewater. The Stikine River rises in British Columbia and breaks through the Cascade Range. The gradient of this river in American territory is so slight that the main stream has no power value.

Wrangell and Petersburg are the ports of this region. These towns owe their development to their situation on the "inland waterway." The water powers of this region are not developed, and very little information regarding them is available. Several small projects have been tentatively considered, including public utilities for Petersburg and Wrangell. A few canneries operate small water wheels, but no detailed information is available for this report. One large undeveloped site is known and is outlined below. Other sites will probably be discovered when the country is more thoroughly explored.
Water Power.

Mill Creek Project is about ten miles easterly from Wrangell. Mill Creek flows into Eastern Passage, a strait connecting Bradfield Canal with Stikine Strait. Mill Lake is located about ten miles from the shore and has a surface elevation of approximately 100 feet above high tide. Its area is said to be approximately 1,000 acres. The minimum power capacity of the site has been estimated to be 3,000 hp., but this figure may be in considerable error. The Forest Service and the Geological Survey are now cooperating in securing data so that accurate estimates can be made.

(*To be Continued*)

"Water Powers of British Columbia," "Water Powers of the Prairie Provinces," "Water Powers of Ontario," "Water Powers of Quebec," and "Water Powers of the Maritime Provinces" are titles of the recently issued pamphlets of the Water Power Branch of the Department of the Interior of Canada. These pamphlets offer a brief review of present and possible water powers of Canada and should prove interesting along with Mr. Lundgren's article on Water Powers of Alaska.

TREATED WOOD BLOCK FOR FACTORY FLOORING AND MISCELLANEOUS USES

Abstract of an address before the American Wood Preserver's Association, January 18, 1916.

BY C. H. TEESDALE

Engineer in Forest Products, Forest Products Laboratory, Madison, Wis.

Since 1900 there has been a steady and rapid increase in the use of creosoted wood blocks for paving the streets of our cities. A more recent development, and one which promises to become an important source of business to the manufacturers of these blocks, has been their adoption for a variety of uses other than street paving. These qualities which make the wood block desirable for flooring where heavy trucking, the moving of heavy machinery, etc., make the maintenance of floors a serious problem, and its use has already been reported for:

Warehouses	Freight platforms	Garages
Factories	Loading platforms	Cotton mills
Factory courts	Station platforms	Paper mills
Foundries	Wharves and docks	Rubber plants
Machine shops (all kinds)	Ferryboats and approaches	Hospitals
Shops handling heavy machinery	Driveways	Laundries
Railroad shops	Bridges	Printing establishments
Round houses	Post offices	Hotel kitchens
Railway stations	Tennis courts	Bakeries
Freight houses	Barns	Fire engine houses
Express rooms	Stables	Milk depots
Baggage rooms	Slaughter houses	Breweries
Dumping platforms	Wild animal cages, runways, etc.	

Method of Manufacturing Wood Blocks for Flooring.

Letters were written to those plants manufacturing creosoted wood blocks requesting data on their methods of manufacture and construction. Not many of the treating plants in this country have as yet produced very much of this product. Reports were received from 13 commercial plants and one railroad

plant. Three of these were in the West, and the remainder in the Central Western, Eastern or Southern States, but probably 90% of the output has been from less than half of these concerns. Eleven additional plants reported that their product had not been used for flooring. All of the concerns manufacturing large quantities of wood block, except one, replied to the inquiry. The replies from these plants are given in a condensed form in Table 1.

Species of Wood.—Eleven of the plants reported the use of Southern yellow or longleaf pine for this purpose. Five plants also recommended Eastern tamarack as being satisfactory, and the three Western plants recommended Douglas fir; black gum, beech, Norway pine, maple, hemlock, and Western larch were recommended by one plant each.

Several of the plants, particularly those producing the largest quantity of this material, pointed out that the wood block flooring problem naturally divides itself into two classes:

A. Blocks used in very dry situations, as in factories and warehouses.

B. Those used in alternately wet and dry, or in wet situations, as in stable floors, docks, wharves, slaughter houses, etc., where the blocks are exposed to the weather, to flushing with water, etc.

The treatment and method of handling the blocks differs radically in the two cases. In Table 1 the reports of the manufacturers have been divided, so far as is possible those under caption "A" designating dry situations only, and those under "B" resignating alternately wet and dry or wet situations.

Preservative.—Eight of the fourteen plants reported in favor of using a distillate creosote oil. Three plants recommended paving oil similar to that quite generally used for wood block street paving. One recommended water-gas-tar; one carbolineum; one a mixture of half water-gas-tar and half zinc chloride solution; and one a mixture of half water-gas-tar and half coal tar creosote. The last mentioned product was, however, recommended only for wet situations, this plant recommending creosote injected by the Rueping process for dry situations. The concensus of opinion was to use a distillate creosote, especially for dry situations, and a heavier paving oil for wet conditions.

Absorption of Preservative.—In general, the plants were not very specific as to the absorption of preventative that they recommended for the two classes of blocks. The inference to be drawn ,however, was that comparatively light absorptions (from 5 to 8 or 10 pounds per cubic foot) would prove satisfactory for dry situations. Heavier absorptions, ranging from 8 to 16 pounds per cubic foot, were recommended for alternately wet and dry or for wet situations. In general, the absorption to be given would appear to depend to a considerable extent upon the conditions met with in each individual problem, the more severe conditions especially as to the chance of the water coming in contact with the blocks, requiring heavier absorption of oil. In the case of plants recommending paving oil and water-gas-tar, heavier absorptions were specified than when creosote was recommended.

Treatment.—It is evident that the use to which the blocks would be put has a very important bearing on whether the timber should be thoroughly dried out before treatment. Three of the largest producers of flooring pointed out that blocks which are to be used in inside construction, especially in factories or other situations where the buildings will be heated in winter and where the blocks do not often come in contact with water should be thoroughly air dried or even kiln dried before treatment; otherwise, if they are comparatively wet when laid they are liable to shrink badly in the floor and become loose. However, if the blocks are to be subject to alternately wet and dry conditions, swelling and heaving are liable to take place if they are too dry when laid. Not all of the plants heard from reported on whether they would prefer to treat green or dry timber for this purpose. However, all of the plants but one reporting on blocks for inside construction preferred air-dry material. One plant specified either air-dry or green. The majority of the plants also preferred air-dry material for blocks in wet situations,although two plants specified their preference for green material and three for either green or air-dry material.

Steaming the Timber.—Of 12 plants replying to this question seven stated that the timber should not be steamed before treatment, and one not if the timber is dry. One plant preferred to

steam lightly in winter, and three plants answered yes to the question. The concensus of opinion, especially in the case of those plants producing the larger amounts of flooring, was not to steam the timber.

Methods of Laying.—Most of the plants stated that a concrete base should preferably be used. Six of the plants, however, stated that where the concrete was not practicable, treated plank would be satisfactory. One plant stated that treated plank foundations should always be avoided, if possible. One plant specified sand and cement base. Practically all of the manufacturers agreed that expansion joints were necessary. Those who reported specified joints ranging from ½ to 2 inches and filled with bituminous filler. Whether blocks are to be laid tight or loose appears to depend upon the use to which they are put. In very dry situations the preference was to have the blocks laid as tightly as possible. For alternate wet and dry situations the plants appear to favor comparatively loose laying. Most of the manufacturers favored a bituminous filler. One, however, specified cement filler, one either a dry sand or a cement grout filler, and one sand filler.

Results Obtained in Service.

Letters were written to a large number of users of wood block flooring, to obtain information on the character of the floors being laid and the results obtained. One hundred sixty replies were received. About 75% of the replies received described floors laid in 1912 or later, while only three records were received of floors laid prior to 1909. This indicates the comparatively recent development of this type of flooring. For this reason also the time of service of these floors has been so short that not much information can be given upon durability.

Methods of Construction.—The depth of block used varied from 2 to 6 in., but 3 in. was used in 56% of the floors concerning which replies were received. Southern yellow pine was used in 72 % of the cases, while 15% did not reply to the question, the remaining 13% being divided between eight other species of wood.

The replies concerning the preservative used are probably not very reliable. In certain cases it was known that water-gas-

tar was used, though creosote was reported. The records were corrected in all cases where the preservative was definitely known. The records show that 67% used creosote, 12% used paving oil, and 8% water-gas-tar, while the remainder used other preservatives, or did not reply to the question.

The reliability of the replies as to the process used is also probably uncertain. It is not likely that all who replied to this question were sufficiently well informed to answer it correctly. Thirty-eight per cent. did not reply, while 48% reported the Bethell process and about 9% the Rueping process The absorption of preservative reported varied from 6 pounds to 20 pounds. Nearly 60% did not reply to the question, but the largest number (9.4%) reported 16 pounds. About 19% reported 12 pounds or less, and 22% reported 15 pounds or more.

Concrete foundation was reported in 80% of the replies, the remainder being plank, dirt, tamped earth, etc., or not answering the question. Seventy-one per cent. reported the use of sand cushion, 12% cement grout cushion, and 3% bituminous cushions. Bituminous fillers were reported by 44%, and sand by 25%. Thirty-nine per cent. reported that expansion joints were used, while 41% did not use them, and 20% did not reply to the question.

Summing up, the general practice was to use 3-in. Southern yellow pine blocks treated with 15 pounds or more of creosote per cubic foot by Bethell process. These were laid with a concrete foundation, sand cushion, bituminous filler, and the question of using expansion joints depended on the local conditions in each case.

Difficulties Experienced.—Repairs have been reported in 32% of the records, while 62% reported no repairs. In most cases the repairs made were of a minor character, and as a rule, were caused by swelling or shrinking of the wood. In a few case blocks were badly worn where heavy castings were thrown upon them.

Bleeding of the blocks was reported in 9% of the records, but was said to be objectionable in only 2.5% of the cases. Swelling was reported in 29% and shrinking in 27% of the records, (in some cases both swelling and shrinking were reported), and

these troubles were the cause of most of the dissatisfaction reported. Swelling occurred when the blocks became accidentally wet, because of leaky roofs, bursting water pipes, near drinking fountains, and other accidental causes. Shrinking occurred in very warm or hot situations, and resulted in the blocks becoming loose and producing an uneven floor.

An interesting relation may be shown between the kind of filler used, and swelling and shrinking reported. Thirty-three per cent. of those using bituminous filler reported this trouble, compared with 55% of those using sand filler, 75% where cement grout was used, and 55% where no filler was used.

Eighty-nine per cent replied that the blocks were satisfactory while 5.6% did not reply to the question, and 5.6%, or nine records, stated that the flooring was not satisfactory. Of the nine unsatisfactory floors, shrinkage of the blocks was responsible for dissatisfaction in three cases, swelling in two cases, in two cases the blocks wore out rapidly, poor foundation in one case and improper laying in one cae.

The advantages and disadvantages as stated in the 160 reports which were received have been recompiled in Table 4. In a large proportion of cases it was reported that wood block was easy on the feet of the workmen and that they like to work on it. Noiselessness, ease of repairs, low upkeep cost, good trucking surface, saving of breakage in tools and fragile metal parts dropped on the floor, warmth, and cleanliness were all reported as advantages of wood block flooring in 10 or more of the records. Durability was reported as an advantage in 77 cases, though it is doubtful if many of the floors had been in service sufficiently long to warrant a statement as to durability.

In 14 records swelling was given as a disadvantage and shrinking in 12 records. Roughness, reported in 11 records was mostly caused by shrinkage. High cost was given as a disadvantage in 11 cases.

General Discussion.

The results of this investigation indicate that treated wood block makes a desirable type of flooring for many purposes, and it is likely that its use for interior work will increase. Since

its large use for these purposes is just beginning, one might expect that unforseen trouble would develop. The records of 160 floors given in this report indicate, however, that serious trouble has developed in a very low percentage of cases.

Most of the trouble has come from shrinkage or expansion of the blocks. To prevent these troubles it is essential to study each case where blocks are to be laid, and to treat the blocks accordingly. For dry situations, the blocks should be well seasoned before treatment and laid in the floor while thoroughly dry. In wet or alternately wet and dry situations, dry blocks would give expansion trouble and hence, the timber should be green or only semi-air-dry when laid. Even dry interiors are liable to be accidentally subjected to water, however; hence, it would seem desirable as a rule to use bituminous fillers instead of sand filler.

Sand cushions were probably a source of trouble in several cases. If there is any vibration, or if the sand is at all liable to shift, a bituminous or cement grout cushion is to be preferred. Sand cushions are also liable to cause uneven floors if the blocks shrink, and it seems likely that many cases of shrinking would not give serious trouble where bituminous or cement grout cushions are used.

Bleeding caused very little trouble. In dry and very warm situations, where it is most likely to occur, it would be desirable to carefully consider the method of treating and handling the blocks in order to avoid objectionable bleeding.

In a few cases it seems likely that wood block should not be used. For example, it should not be used where butter or tobacco products are stored. In some foundries, where hot castings are thrown upon the floor, the blocks have burned through to the foundation. Wood blocks may be objectionable where the soiling or staining of certain classes of merchandise would lower the value, and in one case where used in a tennis court wood blocks were a failure and had to be removed.

Wood block was found to be very satisfactory in many cases where heavy castings are thrown about,where heavy trucks are moved, and is liked by workmen because it is warm and is easy on their feet.

The replies from the users of wood block flooring indicate

quite strongly that when new wood block floors are to be laid, a careful investigation of all the conditions existing or likely to develop should be made by the manufacturer. The method of treatment and construction of the floor should then be adapted to the special conditions found. If this is not done many cases of dissatisfaction are very liable to develop.

A bill has been introduced in Congress to abolish the Fahrenheit thermometer scale and require the use of the Centigrade scale instead in all United States Government publications. In the circulars sent out to test public opinion on such a proposed change the suggestion is made that if a change in the standard scale were to be made, some other scale than the Centigrade might better serve the purpose, as the use of the Centigrade scale requires many minus signs.

* * *

A 150,000-Gal. Activated-Sludge Plant to treat the packingtown sewage has been operated since the latter part of January by the Sanitary District of Chicago. It is under the direction of Langdon Pearse, division engineer, and Dr. Arthur J. Lederer, chemist.

* * *

Work has begun on the proposed new packing house of Armour & Co., at Denver, Colo., the new building to be 125 by 125 feet, and six stories high. The old building will be remodeled for cold storage purposes.

* * *

The importation of coal into Switzerland reached a total of 1,969,454 tons in 1913 and a total of 1,697,251 tons in 1914.

* * *

Th American Association of Engineers is issuing to its members a monthly called *The Nomad,* devoted to the objects of the association, "to raise the standing of ethics of the engineering profession and to promote the economic and social welfare of engineers."

I fear that the student who thinks he is hard worked has much to learn about methods of study.

—*Harrington.*

An educated man with all his vast knowledge and refined emotions is a failure unless his will is trained to do what he knows and feels he ought to do. —*Karapetoff.*

Can you write a letter, stating in clear, distinct, concise, and correct language the facts and opinions which you wish to make known to your correspondents? If you cannot, then your education as an engineer is incomplete.

—*Bates.*

Foresight is the carrying beyond present view the knowledge of things within view. It is the practical man who displays foresight and thus is called wise, or prudent, because through the knowledge of things about him he can extend his judgment to those beyond. —*Kerr.*

The true ultimate value of any position offered to a newly fledged engineer is an inverse function of the salary paid.

—*Waddell.*

Avoid all petty professional jealousies, and remember that to rise in the world it is not necessary to push others down.

—*Waddell.*

Be patient and do not try ot get on too fast. You may be over estimating your own abilities. It takes all summer to ripen the best apples. —*Baker.*

Every time a student leads his instructors to believe he has mastered a point when he has not he cheats himself not out of so much learning, but out of the ability to learn. He has handicapped himself permanently for the sake of an hour of ease, left himself nearer the position of the untaught laborer, and depreciated a little more his chance for success.

—*Harrington.*

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ENGINEERS AND OTHER EXPERTS FROM A NEWSPAPER STANDPOINT

Editorial reprint from Engineering and Contracting, issue of February, 2, 1916.

In an editorial entitled "Engineers and Other Experts," in its issue of January 25, 1916, The Daily News of Chicago says in part:

Speaking generally, the public should be on its guard against the tendency to force it to employ men technically called engineers where experts of different training may serve it better. Engineers get most of their employment from private interests. It

is difficult, therefore, to secure engineers of large practice who will be vigorous defenders of public rights in controversies between the public on the one side and public service corporations on the other.

The editorial in question was inspired by the removal of Professor Bemis as a member of the Chicago traction board by Mayor Thompson, on the grounds that the former is not an engineer. Mr. Bemis, although not trained as an engineer, has continued as the city's representative on the traction board since his appointment by former Mayor Harrison, even though the traction settlement ordinances state that the city's representative shall be an engineer. The Daily News in taking exception to the removal of Mr. Bemis, says:

Certainly Mr. Bemis by this time has gained a familiarity with the problems under consideration which a new appointee will need some time to acquire. It therefore seems unfortunate that an existing arrangement which is giving satisfaction should be suddenly overturned for no other heason than that it may be open to objection on technical grounds.

The following interpretation of the term "engineer" by The Daily News is interesting, especially in view of the fact that engineers themselves have found difficulty in defining the term satisfactorily:

As it is used today, the term "engineer" has a broad application and is often given to men of the requisite high ability in certain lines, even though they have not been given engineer's diplomas in the mechanical, electrical or like professional schools.

The Daily News admits the traction settlement ordinances specify that the city's member of the board of supervising engneers shall be an engineer, but states that Mr. Bemis "has acted many times in capacities where men of engineering experience were needed." In concluding its editorial The Daily News argues that the questions involved are not by any means all engineering in their nature, and that highly skilled and experienced men without engineering training are able to give the public much better service on many of these questions than are men of training in technical and engineering schools.

In view of the fact that The Daily News has a wide following, due largely to its conservative and generally constructive policy,

we deem it necessary to call attention to certain features of this editorial which we consider are apt to mislead its readers and to prejudice them against engineers.

In the first place, we maintain there should be no criticism of Mr. Bemis' removal, as the traction settlement ordinances clearly state that the city's member of the board of supervising engineers shall be an engineer, and Mr. Bemis has not been trained as an engineer. The fact that he has been permitted to act "many times in capacities where men of engineering experience were needed" is certainly no justification for his retention if he is unable to qualify as an engineer. It might as well be argued that the mere holding of a public position by a political appointee who is entirely unfamiliar with the work justifies his retention in that positon.

Secondly, the problems to be met and solved in this case are chiefly engineering in character, and as such can best be solved by a trained engineer. The contention of The Daily News that the "problems involved are not by any means all engineering in their nature" carries little weight, as it is a general statement which might be said of almost any position in which the engineer is called upon to serve. Certainly few would seriously argue that the trained engineer of today does not possess sufficient general education and ability to enable him to solve problems other than those entirely engineering in character.

With reference to The Daily News' interpretation of the term "engineer" we are compelled to acknowledge that a newspaper could hardly be expected to have a clear conception of the term when engineers themselves are unable to agree as to definition. There is at present a tendency on the part of some engineers to classify as engineering many lines of activity which are not engineering at all. Engineers must face the fact that engineering has some limitations and that the successes of some prominent engineers in other lines of work are due not so much to their engineering knowledge and training as to other natural and cultivated abilities. However, The Daily News' assertion that the term is often given to "men of requisite high ability in certain line, etc." is indeed indefinite and meaningless.

The chief cause for resentment on the part of engineers is contained in the statements quoted at the beginning of our edito-

rial; these we assert are not only uncalled for, but are unfair and generally without merit. The success with which engineers have long filled municipal positions of trust, and the entire absence of charges of any kind affecting their honesty in serving the public, should be sufficient evidence that engineers can well be trusted to safeguard public interests. The statement that engineers get most of their employment from private interests is, we assert, no more true of engineers than it is of other professional men whom the city might engage. However, we do not care to argue this point, as it is immaterial in any case. It certainly does not follow—as is claimed by The Daily News—that "it is difficult, therefore, to secure engineers of large practice who will be vigorous defenders of public rights in controversies between the public on one side and public service corporations on the other." Such an assertion is ridiculous and vicious, as its evident intent is to lower the standing of engineers in the eyes of the public and thus deprive the latter of the kind of service for which the engineer's training particularly fits him. We agree with The Daily News that what the public desires is service, and it is on this ground that we ask for the appointment of an engineer to fill the vacancy left open by the removal of Mr. Bemis. The editorial in question is but another indication that engineers have much work yet to do before the public and its organs are educated to a full realization of the value and extent of the service which the engineer is capable of rendering.

Professor W. S. Franklin, formerly of Lehigh University, Bethlehem, Pa., delivered a lecture in Science Hall on January 13 to a large and enthusiastic gathering of students and instructors. The lecture dealt with the fundamental electrical quantities and their relations. These were explained in simple language and illustrated by analogies that served to give the student a clearer understanding of some of the common electrical terms. Prof. Franklin enjoys the rather unusual characteristic of being able to explain physical phenomena by means of simple analogies that are easily grasped by the student.

A report compiled by M. J. Faherty, president of the board of local improvements, city of Chicago, shows that 147 miles of Chicago streets and alleys were paved during 1915. The aggregate cost was $4;500,000. The same report shows that approximately 160 miles of paving work was done in 1914.

Of this paving mileage the official report shows that during the year 1915 fifty miles were paved with asphalt. Of the other work and of the materials used there were: 19.5 miles, Asphaltic concrete; 34 miles, asphaltic macadam; 21.5 miles, brick; 4 miles, creosoted blocks; 3.5 miles, granite blocks; 14.5 miles, concrete.

The assessment for the paving of Wentworth avenue, from Twenty-sixth to Thirty-ninth street, in which creosoted blocks were used, was $101,000.

"The Duties of a Patent Office Examiner" was the subject of a very interesting address before the junior and senior classes of the College of Engineering by Mr. John A. Diener, patent attorney of Washington. Mr. Diener discussed the civil service examinations, the salary of the examiner, the life at Washington, and presented views taken at the Capitol. The work is divided into forty-one divisions, or departments, and each division has a chief examiner with a corps of assistants. Mr. Diener presented his subject in a very interesting manner and several of the students have evidenced a desire to engage in the work.

That water-power development in the West is hindered more by lack of a market for the power when developed than by the existing state and Federal restrictions is the opinion set forth in the annual report of the chief of the Forest Service. We read: "With rare and minor exceptions, existing power developments in the Western States are far in excess of market demands." The Forest Service is being constantly importuned to extend periods of construction on power permits on the plea that there would be no market available for the power if the project were developed."

COLLEGE NOTES.

ARMOUR INSTITUTE OF TECHNOLOGY BRANCH OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

An open meeting was held during school hours on February 18, 1916, attended by the Sophomore, Junior, and Senior classes of the College of Engineering. Mr. Osborn Monnett, former Smoke Inspector of the City of Chicago gave an illustrated talk on "The Engineering Phases of Smoke Abatement Work."

Mr. Monnett spoke from a practical standpoint as he said, "I had no schooling at all, but worked up in the engine room from oiler to chief engineer."

The substance of the lecture was the damage and expense incurred by the smoke and the subsequent remedying of this nuisance. Mr. Monnett told of the hard crust that soft coal smoke deposits on buildings and of the skill required to remove it; the scrubbing and sand blast processes which are necessary in some cases for this removal were also described. That the owners of the Railway Exchange Building find it necessary to expend $1,500.00 yearly to accomplish this work was the statement of Mr. Monnett. He also said that hard coal would remedy this nuisance to a certain extent, but due to the fact that the

soft coal fields were near the large population centers, it would be impractical to use hard coal.

Illustrations of how to use the Ringelmann Smoke Chart for the determining of smoke densities of 20, 40, 60, 80, or 100% were given. It is not a nuisance, or so considered, if we can see thru the smoke.

At the beginning of the work on smoke abatement it was found that the return tubular boiler gave the most trouble, producing about 90% of the smoke. This resolved the work into a determination to find a means of improving this boiler so that it would not smoke. Many slides showing the boilers before and after being perfected and the amount of smoke given out before and after this perfection.

The great importance of this work on the conservation of smoke was forcibly advanced by Mr. Monnett in his closing remarks and which would mean: A City Beautiful, Health, More Sunlight, Better Vegitation, Clean Homes, and Happier People.

E. S. Echlin.

THE CIVIL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

A regular meeting was held on January 4, 1916, at which Mr. Ford of the Du Pont Powder Company delivered an illustrated lecture on "The Use of Explosives in Engineering." The use of explosives in ditch building, road building, and other engineering projects is increasing and that there will be a greater increase is due to the fact that the cost is small as compared to other methods. In farming, explosives are being exclusively used for breaking up new land and also for planting trees. The explosives loosen the earth for a large area about the point at which they are ignited; and the roots of trees and plants can be easily spread into this loose earth On the other hand, when the earth is shoveled up the ground about the hole is still intact and the roots of plants and tree do not spread as far and consequently do not obtain as much nourishment as they do in the first case. Mr. Ford also showed the kinds of explosives to use for different jobs and the method of handling and placing the powder to obtain the best results.

On February 1, 1916, the meeting was addressed by Mr. Sharples of the Barrett Manufacturing Company Mr. Sharples spoke on "Bitumens and Their Uses" and illustrated his talk with many interesting slides showing the manner of preparing the subgrade, placing the foundation, and the applying of the bitumen. The different kinds of machines used to apply the bitumen were also shown and their good and bad features pointed out. Mr. Sharples stated that the life of many of our pavements could be lengthened by using proper maintenance methods and cited cases of the care taken by European engineers in the maintenance of highways and the gratifying results obtained.

Mr. Doan, a former Armour student, now employed by the Illinois Highway Commission, was present at this meeting and explained the nature of the work done by an inspector of roads. He gave a brief outline of the questions likely to be asked in the Civil Service examination for Junior Highway Engineer; and also answered a number of questions asked by the students contemplating taking the examination.

Civil Inspection trip.

On Wednesday, February 16, 1916, the students of the Civil Engineering Department, as guests of the Universal Cement Company, visited the plant of that corporation at Buffington, Ind. Upon arrival at the plant, the different processes involved in the manufacture of cement were explained by Mr. Wilsnack, formerly Asst. Prof. of Chemistry at Armour, and now chief chemist at this factory. The party was then divided into groups of 8 and each group under the leadership of a guide started a survey of the plant.

The slag and limestone are first ground separately and then mixed by being dumped from hoppers which automatically proportion the amounts of each product used. This mixture is then heated to incipient fusion, producing what is called the clinker. The clinker is placed in the open air and allowed to cool; after which it is ground and mixed with gypsum, giving the finished product. During the various stages of manufacture the product is tested to see that the cement is up to the required grade. The finished product must conform to the tests advocated by the American Society for Testing Materials.

H. W. Hemple.

FIRE PROTECTION ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY

Many a student lost the opportunity, on the evening of January 11th, to gain an insight into the most modern plights of the engineering field, i. e. "Safety Engineering". The lecture on this subject, as delivered by Mr. S. V. James (B. S. '07, M. E. '11), Head of the Casualty Department, Underwriters' Laboratories, was a most conclusive review of the entire field of the new work, skillfully illustrated throughout by slides arranged by the National Safety Council of America.

Mr. James opened his very enjoyable lecture by giving the purpose of the safety engineer and citing the fact that every engineer should adopt the principles of safety engineering and thereby do away with the specialist along this line. The necessity of the new field of endeavor was shown by giving statistics of the casualties during the year 1913. During this year there were forty-five thousand (45,000) deaths due to accidents and two hundred thousand (200,000) working days lost at a cost of six hundred million dollars ($600,000,000.00).

The causes of the accidents were classified, in general, as follows:

(1) Trade Risks (Incidental and Non-preventable) (10%)

(2) Negligence of Company (15%)

(3) Neglect of Workmen (75%)

These need no further explanation, although attention may be called to the high percentage of the causes due to the negligence of the workmen. It would follow directly from this fact that the preventative means must be principally applied to the workmen.

The methods used to prevent accidents were next discussed. These may be thrown into the following three classes:— (1) Organization; (2) Education; (3) Safeguarding. Under the first division come the organization of safety committees and safety departments to take care of that branch of work. Safety talks to the men as well as disciplinary measures along the line of cleanliness and carefulness are illustrative of the preventative measures classified under education.

Safeguarding is by far the best preventative. Inspection work for safeguarding has gained widespread popularity recently. The inspection is first made for the need of safeguarding; second,

for the installing of safeguarding; third, for the maintaining of safeguarding; and fourth, for the use of safe guarding. Many interesting slides demonstrated how the inspector carried on his work. The safeguarding of exposed gears and other parts of machines received great attention.

Other safety devices may be listed as follows:— blue prints giving precaution; placards calling for "safety first;" safety books; safety bulletins; danger signs; and safety slogans on time cards.

The results accomplished by safety campaigns were remarkable. In a long list of cases given by Mr. James, the percentage of accidents was reduced between twenty-two (22%) and seventy-three (73%) per cent.

Mr. James closed his very interesting lecture by pointing out the work of the Underwriters' Laboratories along the line of "Safety Engineering."

Much credit is due Mr. James for preparing such an interesting lecture and the Fire Protection Engineering Society certainly assures him that it was appreciated to the greatest extent. Although the president tendered him a vote of thanks after the lecture, it would not be out of the way to thank him once more through these lines.

On the evening of February 8th, the Fire Protection Engineering Society had the pleasure of being addressed by Mr. Claude Alling (B. S. '07), Head of the Sprinkler Department, Underwriters' Laboratories, on the "Testing of Automatic Sprinklers." Mr. Alling delivered a very concise and straightforward lecture covering the various tests at the Labroatories on sprinkler heads.

The early development of the sprinkler systems was first traced from the perforated pipe types to the use of solder in the sprinkler head by Parmalee in 1807.

The heads were classified as follows:—(1) Straight strut type as illustrated by the Grinnell head; (2) Lincoln lever type as illustrated by the "Evans" head. The classification according to the temperature of operation was also given. The ordinary head operates at about 160 degrees F., and the specials at 212 degrees F., and 360 degrees F.

Mr. Alling then reviewed the test work on these sprinklers.

The various parts of the work are enumerated as follows:—(1) Examination of sprinklers; (2) Analysis of Mechanics of Head; (3) Study of Design; (4) Materials for Construction; (5) Physical and Chemical tests; (6) Water Hammer Test; (7) Installation Test; (8) Operating Test; (9) Release Test; (10) Excessive Stress Test; (11) Service Test; (12) Distribution Test; (13) Strength Test; (14) Inspection of Manufacturer's Plant; (15) Life of Sprinklers. The accuracy with which the various parts must be made caused a little surprise. Only .001 of an inch is allowed for variation in the distance from the disc to the deflector and only .002 to .004 of an inch in the links and levers.

Mr. Alling closed his lecture by pointing out the good work of the sprinkler in the case of fires. In ninety-five per cent (95%) of the cases, the sprinklers have operated satisfactorily. Over eighty-two per cent (82%) of the cases have been controlled by ten sprinklers or less. This is a very credible record, considering that the five per cent (5%) of failures were due chiefly to the improper designing, installing or maintaining of the system itself and not to faulty sprinkler heads.

The Fire Protection Society would like to congratulate Mr. Alling for the straightforward way in which he prepared his lecture and to express its appreciation of his kindness in sacrificing his valuable time to speak before us.

A. Corman.

Certainly the man most in demand today is the one who combines thorough training with natural executive or adminisrative ability. —*Smith.*

The practical man thinks quantatively and qualitatively, while the impractical thinks qualitatively only. —*Kerr.*

A SELECTED LIST OF BOOKS RECENTLY ADDED TO THE LIBRARY OF THE COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING

Arnold, Horace Lucian and Faurote, Fay Leone. Ford methods and Ford shops. N. Y., Engineering Magazine Co., 1915.

Browne, Arthur Benjamin. Handbook of carburetion. N. Y., J. Wiley & Sons, 1916.

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Tenney, Edward Henry. Test methods for steam power plants. N. Y., D. Van Nostrand Co., 1915.

Thurston, Robert H. A treatise of friction and lost work in machinery and millwork. 7th ed. N. Y., J. Wiley & Sons, 1907.

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Walker, Miles. Specification and design of dynamo-electric machinery. N. Y., Longmans, Green & Co., 1915.

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Mead, Daniel Webster. Water power engineering 2nd ed, N. Y., McGraw-Hill Book Co., 1915.

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Scriven, George P. The service of information. United States army. Washington, Government Printing Office, 1915.

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Buhler, F. A. Filters and filter presses for the seperation of liquids and solids. N. Y., D. VanNostrand Co., 1914.

Ellis, Carleton The hydrogeneration of oils. N. Y., D. Van Nostrand Co., 1914.

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White, Charles H. Methods in metallurgical analysis. N. Y., D. Van Nostrand Co., 1915.

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Hudson, William Henry. Introduction to the study of literature. Boston, D. C. Heath & Co., n. d.

THE ALUMNUS

Being That Part of **The Armour Engineer** Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

T. A. Banning, Jr. F. T. Bangs W. A. Kellner

Communications should be addressed to T. A. Banning, Jr.
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TWENTY-FIFTH ANNIVERSARY CELEBRATION.

In the preliminary plans for this event, as published in an earlier issue, it was decided to provide for the addition of three members to the committee each year. The committee now consists of F. A. Lindberg, '01, chairman; E. O. Griffenhagen, '06; H. W. Clausen, '04; F. G. Heuchling, '07; F. M. de Beers, '05, and A. S. Alschuler, '99.

At the last spring meeting and the mid-winter meeting about 200 graduates pledged subscriptions of $10, payable in four installments, and which will cover the individual cost of entertainment. Just what this entertainment will consist of has not been definitely settled, as it is obviously impossible to do so at this time. At the same time the alumni may be sure that they will receive their money's worth. It is the intention of the committee to send out a notice shortly calling for the payment of the first installment of the subscription, and it is strongly urged that the alumni respond promptly, so that the committee can form some idea of how much money they can probably collect,

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(Signed) ARTHUR KATZINGER,
Business Manager.

Sworn to and subscribed before me this 6th day of March, 1916.

[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires January 8th, 1918.

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MAN AS A MACHINE

BY G. E. MARSH.

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The most general inquiry that a technical man makes in considering an engine or motor is the question of efficiency. The simplest and most common definition of this term is the ratio between work done and energy used and expressed in per cent. The law of conservation of energy is the basis on which all determinations of efficiency of machines, considered as transformers of any one kind of energy into another or into work are founded, and hence the sum of all work done plus the sum of all transformed energies equals the sum of all energies consumed. The work of Rumford in 1798 was the earliest experimental compilation of the Law of the Conservation of Energy, and the works of Mayer, 1842; Joule, 1845, and Rowland, 1888, gave us values for the mechanical equivalent of heat.

The rate at which work is done is called activity and is expressed in such units as the watt and horsepower. The latter was established by Watt from experiments on London draft horses and is larger than his actual results. In rating his engines in this unit, he explained that he did so in order that no purchaser of his engines would part to find it equal to the number of horses that had been displaced.

The rate at which a machine can do work is a variable and it is generally that the transformation of a given amount of energy into the greatest amount of work and at the greatest rate are opposed to each other. This is the same as saying that the efficiency is dependent on the activity.

In the case of an electric magnetic engine the efficiency is highest when the current is smallest; that is, when its power is smallest.

The work that a man has been found capable of performing in a given time, ten hours, is given in Tables 1 and 2. The val-

ues in Table 2 are the averages for the several classes of labor contained in Table 1.

TABLE I.

Man's Work Capacity.

Kind of Work	Work Done in Foot-pounds.
Mine work (Coulomb)	723,300
Boring (Weisbach)	1,020,000
Elevating water (Morin)	847,000
Tamping (Coulomb)	544,000
Tamping (Ruhlmann)	468,000
Tamping (Lahmeyer)	416,000
Pile driving	1,035,000
Pile driving	1,325,000
Tamping (Weisbach), 4 men, 123 pound weight—	
4.1 feet high, 10,200 times a day	1,292,000
Raising 75 lb. 0.82 ft. per sec. for 5 hrs.	1,107,000
Raising 6,275 lb. 128.5 ft. by treadwheel (Coulomb)	890,000
Operating treadwheel (S. Smith)	866,000
Operating treadwheel (Hachette)	839,500
Using windlass (Coulomb)	922,500
Using windlass (Weisbach)	822,500
Using windlass (Rokeit)	1,005,000
Using windlass, 4 men (Lempe)	1,013,000
Using windlass, 2 men (Lempe)	999,000
Using windlass (Rziha)	1,150,000
Using lever (Weisbach)	942,000
Using lever (Haslett and Hackley)	1,100,000
Using lever (Morin)	1,135,000
Pulling a boat (Hachette)	797,000
Climbing without load (Hachette)	1,012,000
Climbing with load (Hachette)	840,000
Climbing with load (Coulomb)	823,000
Climbing with load (Comkes)	950,000
Shoveling earth	912,000
Technical work (Paff) 10 hrs. in 12 hr. shift	912,000
AVERAGE	922,000

TABLE II.

Man's Work Capacity in Various Kinds of Labor.

Kind of Labor	Work Done (foot-pounds)
Shoveling earth	912,000
Digging, boring	872,000
Tamping	884,000
Pumping water	848,000
Pulling boat	796,000
Treadmill	865,000
Climbing without burden	1,012,000
Climbing with burden	884,000
Using windlass	987,000
Using lever	1,061,000
Technical work	912,000
Average	922,000
Average horse-power	0.0466

TABLE 3.

Man's Work Capacity.

Kind of Work	Force Lb.	Velocity Ft. p. sec.	Time Hr. p. day	Power Ft. lb. sec.	Work Ft lb. day
Walking, no load	.140	1.66	10	700	6,120,000
Raising weight					
Walking, with load	90	2.5	7	225	5,670,000
Climbing stairs	143	0.13	8	...	2,030,000
Climbing stairs, with load	143	0.13	10	18.5	665,000
Tread mill	143	0.5	10	71.5	2,575,000
with rope	40	0.75	10	30.0	1,066,000
Raising weight with hands	44	0.55	10	24.2	867,000
Capstan	26.5	2.	10	53	1,905,000
Crank	18	2.5	10	45	1,620,000
Pump	13	2.5	10	33	1,188,000
Hammer	15	..	10	..	600,000
Shoveling earth up 5.25 ft.	6	1.3	10	7.8	280,000

Wheeling barrow.					
return empty	132	1.66	10	220	7,920,000
2 wheel barrows	224	1.66	10	373	13,428,000

According to Gillett, the pulling power of horse averages one-tenth its weight when excited for ten hours. Thus a 1300 pound horse will pull 130 pounds on the traces. With a good foot-hold this force can be increased to 0.4 of its weight. No horse would be capable of working at this rate except for brief intervals.

On the authority of Gillett, a man weighing 150 pounds can pull steadily with a force equal to 5 per cent of his own weight at the rate of 220 feet per minute for a day of 10 hours. This calls for an expenditure of 990,000 foot pounds of energy and is in addition to the energy consumed in raising his own body at every step which he estimates is equal to 1,000 foot pounds, assuming that the average elevation of the body at each step is one-seventh of a foot. A 150 pound man climbing a vertical distance of 1000 feet in an hour expends energy at a rate greater than 0.0758 horse-power. Coulomb found that in mountain climbing an ascent of 46 feet per minute was a fair value for short periods. Assuming a man's weight as 150 pounds, this corresponds to a horse-power of 0.209

If a man be assumed to be capable of doing a million foot-pounds of work a day, and if the wage of the man is $1.50 a day, then $1.50 represents the cost of one million foot-pounds of work when done through the agency of the human body.

On the authority of Gillett[1], a man weighing 150 pounds can pull steadily with a force equal to 5 per cent of his own weight at the rate of 220 feet per minute for a day of 10 hours. This calls for an expenditure of 990,000 foot-pounds or energy and is in addition to the energy consumed in raising his own body at every step, which he estimates is equal to 1,000,000 foot-pounds, assuming that the average elevation of the body at each step is one-seventh of a foot. A 150 pound man climbing a vertical distance of 1,000 feet in an hour expends energy at a rate greater than 0.0758 horsepower. Coulomb found that in mountain climbing an ascent of 46 feet per minute was a fair value for a short period. Assuming a man's weight as 150 pounds, this corresponds to a horsepower of 0.209. If a man be assumed

to be capable of doing a million foot-pounds of work a day, and the wage of the man to be \$1.50 a day, then \$1.50 represents the cost of one million units of work done through the agency of the human being. Taking ten hours to the day, the average activity is 1,000,000/10x60x33,000, or 0.5005, practically 1/20 horsepower, or 37.5 watts. The 375 watt-hours, or 0.375 kilowatt-hours, of energy have cost \$1.50, or at the rate of \$4.00 per kilowatt-hour, and this is from forty to eighty times the cost of the same amount of electrical energy. If the entire working time of a laborer be taken as equivalent to forty years, then his life's output of useful mechanical work is 0.375x365x40 = 5,500 kilowatt-hours = 18,740,000 B. t. u. Now this amount of electrical energy would cost, at 6c per kilowatt-hour, \$330.00, and its equivalent in gas at \$0.80 per 1,000 cubic feet is worth \$21.00, and in good coal at \$5.00 a ton, \$3.23.

Nystrom[2] states that a laborer can do 1,440,000 foot-pounds of work in an eight hour day. This is at variance with other authorities. Haswell[3] cites the case of an ox whose activity was 268.8 horsepower when moving 120 feet per minute and pulling with a force of 154 pounds. The correct value for the horsepower of the ox is 0.562. He also makes the statement, "A horsepower in work is estimated at 33,000 pounds raised one foot in a minute; but as a horse can exert that force for only 6 hours per day, one work horsepower is equivalent to that of 4.5 horses, at a rate of three miles per hour." This statement is to be found in the fifty-eighth edition of an engineer's handbook.

The energy output of any machine, man, or animal, is given by the equation:

$$E = F\ V\ T \qquad (1)$$

where E = energy in foot-pounds,
F = force in pounds (weight),
V = velocity in feet per hour,
T = time in hours;

and it is assumed that the force and velocity are constant during the time "T." In the case of a living machine the force that may be overcome in the performance of work is determined by the velocity and the hours per day that the activity is maintained. Thus:

$$F = f\,(V\ T) \qquad (2)$$

and if

$$E_0 = F_0\ V_0\ T_0 \qquad (3)$$

are specific normal values that by measurement have been found correct for the average daily conditions in some particular kind of physical work, then the following empirical formula for the calculation of a new and corresponding value for the force (F_1) for new values of the velocity and time, has been given by Gerstner. Thus, if V_0, T_0, become V_1, T_1, we have

$$F_1 = F_0 \quad 2 - \frac{V_1}{V_0} \quad 2 - \frac{T_1}{T_0} \qquad (4)$$

Mescheck proposed:

$$F_1 = F_0 \quad 3 - \frac{V_2}{V_0} - \frac{T_2}{T_0} \qquad (5)$$

At the new rate, the work a man may be expected to do is given by

$$E = F_1\ V_1\ T_1 \qquad (6)$$

where F_1 is determined by either of the equations (4) or (5).

If the time T_1 assume the value T_0, the normal duration of daily work, then equations (4) and (5) take the form

$$F_2 = F_0 \left(2 - \frac{V_1}{V_0} \right) \qquad (7)$$

This value of F_1 is then the force that a man can exert if he is to work at a speed V_1/V_0 times the normal for the normal duration of labor, T_0.

If a man works for short periods, with intervals of rest, these being long in comparison with the working time, then, placing $T_1 = O$, we find that the physical force that can be developed, as given by equations (4) and (5), is

$$F_1 = 2 F_o \quad (8)$$

$$F_1 = 3 F_o \quad (9)$$

and, on the authority of Ruhlman, the latter is in better accord with actual practice.

If the velocity be doubled, $V_1 = 2 V_o$, and the periods of rest are long in comparison to the working periods, then

$$F_1 = O \quad (10)$$

$$F_2 = F_o \quad (11)$$

Euler[15] in 1752 proposed the formula for living machines

$$F_2 = F^1 \left(1 - \frac{V_1}{V^1}\right)^2 \quad (12)$$

in which F^1 is the greatest force that can be exerted by any living machine without producing motion, and V^1 is the greatest velocity that can be generated without bringing into action resisting forces. Numerical values of these forces have been given as: $F_1 = 21,700$ pounds; $V_1 = 5,250$.

The most advantageous velocity for a man pulling horizontally is 2.48 feet per second, and by Euler's formula the corresponding force is 29.3 pounds. The resulting activity is $F V =$ 72.7 foot-pounds per second, or 0.132 horsepower, and the work done in ten hours is 2,615,000 foot-pounds.

These values for the force and velocity have the confirmation of Langsdorf[16] when a man is employed for eight hours a day.

Navier[17] states that the work done by man pulling horizontally for eight hours can be taken as 207,360 meter-kilograms, or 1,500,000 foot-pounds, the force and the velocity being 26.4 pounds and 1.94 feet per second.

Coulomb gives an expression for the useful external power that a man develops in carrying a load, F, (in addition to his own weight) up an ascent. It is

$$\frac{(205 - 1.41 F) F}{70 - F} \quad (13)$$

Man's weight is taken as 70 kilograms. The maximum activity is attained with a load of 53 kilograms, and with a load of 145 kilograms the activity is zero; that is, no ascent could be made.

TABLE.

Effiiciencies 4, 5.

Machine.	% efficiency.
Electric motor	65-95
Steam engine (thermal efficiency)	6-23
Triple expansion engine	17
Steam turbine (Parsons)	23
Steam turbine and generator	16.5
Steam turbine and geenrator	16.5
Parsons steam turbine and generator	20.5
Maximum theoretical thermal efficiency of ideal engine working under same conditions	30.6
Water-wheeel (tangential)	75-85
Water-wheel (reaction)	80-85
Gas engine	16-33
Diesel engine	40
Locomotive (coal to draw-bar efficiency)	2.4-4.6

TABLE 4.

Cost per horsepower of various machines.

Machine.	Cost.
Electric motor	$25-50
Steam engine	10-30
Steam turbine	$20-40
Water-wheel	$ 2-13
Gas engine	$30-50

As a result of the detailed extensive experiments of Atwater[9] and others, the application of the law of the conservation of energy to the human body is not questioned. The experimental confirmation is difficult, and when, considering the complexity of the problem when fully analyzed and the great difficulties in the way of exact measurements, an energy balance between the summation of the input and the summation of the output is in agreement to 0.2 per cent, there is little reason to question that energy changes in physiological process are in accordance with the law of the conservation of energy.

Mayer[7] in 1887 considered the human organism as a heat engine receiving energy in the form of food, and supposed the work done to be the equivalent of the heat produced by the oxidation of carbon and hydrogen in the food to carbon dioxide and methane

respectively. He assumed that an average man in good health consumed 242 grams of carbon and 15.58 grams of hydrogen, in food combination, per day of 24 hours. The oxidation of these elements gives a total of 2,573,080 small calories, as follows:

$$252 \times 8{,}080 + 15.58 \times 34{,}462 \doteq 2{,}573{,}080$$

the heats of combustion of the two substances being 8,080 and 34,462 calories per gram. The heat equivalent of a foot-pound is 0.3241 calories or 0.001286 B. T. U. The work equivalent of this amount of heat energy is therefore 2,573,080/0.3241 = 7,940,000 foot-pounds.

Taking the figures of Saussure, Coulomb, and Navier, as the work done by a man in climbing, Mayer obtains as the corresponding efficiencies:

$$\frac{2{,}370{,}000}{7{,}940{,}000} = 29.8\% \qquad \frac{1{,}700{,}000}{7{,}940{,}000} = 21.4\% \qquad \frac{2{,}030{,}000}{7{,}940{,}000}\ 25.6\%$$

The efficiency calculated on the basis of 922,000 foot-pounds as an average day's work gives 11.6 per cent. The heat value of the daily food of the average man engaged in moderate muscular work is given as 3,500 large calories. If we assume that his useful external work is a million foot-pounds, then his efficiency as a machine is given by

$$\frac{10^6 \times 3.241 \times 10^{-4}}{3.500} \times 100 = 9.26\%$$

since 3.241×10^{-4} large calories equal one foot-pound. As a matter of fact, since a man consumes food every day in the week, but labors only six days, the correct value of the efficiency is 6/7 of the above value.

Schreber[8] and others have regarded the human body as a thermo dynamic engine working between the temperatures of 37°-39°C., the average value of the body temperature of a healthy man, and 17°C., the average value of the surrounding air. This gives, by the well-known law for the maximum efficiency of an engine working between two temperatures, viz.:

$$\text{Efficiency} = \frac{T_1 - T_2}{T_1 - 273} \times 100$$

If this application of the thermodynamic law is valid, a man cannot convert more than 6.5% of the energy in his food into work.

As a confirmation of the correctness of this value, Schreber finds that, using Grassman's[14] as the thermal efficiency in a man's daily (24 hours) food consumption, which are, per 100 kilograms of a man's weight:

Man at rest ....3400 calories
Man at moderate work........5400 calories
Man at strenuous work........7600 calories

and Rziha's[13] value of 127,000 kilogram-meters (918,000 foot-pounds) the efficiency is, assuming a man's weight as 60 kilograms, and that he is doing hard work,

$$6.5 = \frac{127{,}000}{4560 \times 428} \times 100$$

The factor 428 is the number of kilogram-meters equivalent to one calorie. Schreber thus considers that he has proved the validity of the application of a thermodynamic law to the transformation of energy in the human body.

Zunst[9] declares that the Carmot cycle is not applicable to man, as he can work when the temperature of the surrounding air is 370°C. (98.6°F.), and this would require a zero efficiency. His determination of the value of the efficiency of man as a machine is 39-40 per cent, of which 31-34 per cent are available for external work, and 6-7 per cent are consumed within the body. According to the method of Schreber this would require a body temperature of 244°C. Further, if it is contended that there is an oxidation of carbon into carbon dioxide directly in the muscles, as has been suggested as the explanation for the production of muscular work, there would be involved a temperature measured in thousands of degrees.

Let us now ascertain how a man compares with other machines for transforming energy into work on the efficiency-per-unit-of-capital basis. In the case of two machines costing $10 and $20 per horsepower of output, and with efficiencies of 40 and 85 per cent respectively, the efficiencies on a unit-of-capital basis are

$$\frac{40}{1} = 40 \text{ and } \frac{85}{2} = 42.5$$

since the value of the capitals involved per horsepower are in

ratio of 1 and 2. No account is made of the cost of the energy supplies to the machine, and on this basis, if the second machine had an efficiency of 80 per cent, it would be immaterial which of the two were used.

If we choose to compare man with other machines for doing mechanical work, and on a basis of cost, we require the value of a man and so much capital. To this end we may make a choice between two values, one determined in accordance with the theory of Petty, and another put forward by Smith[10], Farr, and Engler. The first valuation of the economic worth of a man to society was made by Sir William Petty, and he assumed that the income of the individual was the proper basis for calculation. Taking the earning power of a man at his present age, and using his expectancy of life as obtained from insurance tables, his economic value is readily found. The following table is on the basis of an earning power of one dollar a day.

TABLE.

Economic Value of a Man.

Age	Value in Dollars
20	6,342
25	6,132
30	5,833
35	5,883
40	5,235
45	4,827
50	4,359
55	3,849
60	3,309
65	2,766
70	2,224

Adam Smith, Dr. Farr, and others, maintain that the economic value of a man is the present worth of his probable future earnings, less the cost of his maintenance, education, etc. On this basis we have the value of the average man given in the following table:

TABLE.

Economic Value of a Man.

Age	Value in Dollars
0	90

5	950
10	2,000
20	4,000
30	4,100
50	2,900
80	700

The average economic value of the inhabitants of the United States as determined by the age of distribution of the 1900 census was $2,900. Fisher[11] considers that $525 a year is a safe minimum for the estimation of the average earnings of all American men who are actually at work. Nicholson considers[12] that the living capital of the United Kingdom is worth five times all other capital.

Assuming that the economic worth of a man is $2,900, that a fair estimate of his average capacity for work is one million foot-pounds in ten hours, and consequently his activity is 0.0505 horsepower, we have that his economic value per horsepower is $2,900/0.0505, or $57,400. Compare this amount with $27, which represents the average capital-equivalent per horsepower of ordinary sources of power. The showing that man makes when considered as a machine and estimated on the basis of capitalized value per unit of power output is exceedingly interesting and astonishingly poor.

If we now use our own value of the energy efficiency of a man, 9.26%, and his capitalized value per horsepower, and make a comparison with the two typical prime movers, we have, from the following data:

	Man	Small Steam Engine and Boiler	Small Gas Engine
Efficiency, %	9.26	5	15
Capital per H. P.	$57,400	25	50
These are as	1 to	0.000436 to	0.000872

the efficiencies-per-unit-of-capital-involved as

	$\frac{9.26}{1}$	$\frac{5}{0.000436}$	$\frac{15}{0.000872}$
or	9.26	11,500	17,250
or	1	1,243	1,865

It is thus seen that man regarded merely as a machine and on

a basis that takes into account only his relative efficiency and his value as so much capital, his rank is extremely low. Several other factors would be included in a complete comparison, but the above ones are sufficient for the present purpose. Mention might be made, however, that if fuel costs were taken into account, then, since food costs thirty or more times as much as coal or oil, the difference would be correspondingly increased.

All of the results of the study of man as a machine for transforming energy into work that is to be valued only on its foot-pound basis should be discouraged, as it represents tremendous inefficiency and waste of human effort that should be employed in doing what no machine can do—namely, work that demands brain-supervision.

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ARMY AND CIVILIAN METHODS OF HANDLING MATERIALS IN PANAMA.

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The construction and completion of the Panama Canal across the Isthmus of Panama is the greatest engineering feat ever accomplished by man, and many problems had to be solved in connection with the work. The locks at Gatun are of unusual prominence, as they are larger than those at Pedro Mignel or Miraflores and contain more concrete than any other piece of work in the canal construction. In connection with the building of the immense locks, the general dimensions of which are known to every technical reader, it was of essential importance to employ most economical methods in the arrangement of plant equipment, power supply, and transportation facilities.

An excellent opportunity is afforded the observer to compare the different methods adopted in the handling of concrete materials in the Atlantic and Pacific Divisions of the Engineering Department. In the Atlantic Division, the Engineers in charge of construction were officers of the United States Army, while in the Pacific Division, the civilian engineers had charge of the work. The concrete construction was commenced in the Atlantic Division, making it necessary for the Army Engineers to work out their own methods first. While some of them seem more or less fanciful at present, they are deserving of great credit in having successfully accomplished the complete construction of the locks at Gatun.

The civilian engineers had the advantage in that they had the opportunity to observe the results of the Atlantic Division and could therefore arrange their plant equipment accordingly. However, entirely different methods were adopted by the civilians and the results proved that their methods were more expedient and operated at a less cost. The two methods will be described in general to illustrate the manner in which they were carried out:—

Concrete Mixing Plant at Gatun.

In the laying out of the concrete mixing plant for Gatun, the geographical conditions seemed to favor the west side of the

locks for its location. On the one side were the locks and on the other were the industrial and supply tracks of the Isthmian Canal Commission, hereafter called the I. C. C. tracks, and an arm of the sea, which was formerly the East Diversion of the Chagres River, giving direct water connections which were advantageously made use of. Materials arriving by water could be easily handled and arrangements were made for this feature.

It will be necessary to give some detail descriptions of the buildings, the automatic and Industrial Railways, the mixers and cable ways, and the accompanying sketch will give their approximate locations with reference to the center line of the canal.

The cement house, which was located between I. C. C. tracks and the edge of the East Diversion, was a large building equipped with a traveling crane to unload and move the cement. The cement was brought to the cement house in box cars directly from the steamers and stored until required for use. Cement was shipped in barges when the canal equipment was required for other service.

The storage piles of rock and sand were located between the service tracks of the Panama Railroad and the locks. The sand and rock was shipped in barges from near-by points on the Atlantic Coast. The method of unloading the barges and transferring it to the storage piles was by means of five cableways extending the entire length of the storage piles and across the diversion, a span of about 1300 feet. This proved a very efficient method for the unloading of material. The barges transporting the rock and gravel were brought under the cable ways. The cableways were equipped with clam shell buckets, which unloaded the material from the barges and deposited it directly in the storage piles.

The novel feature of the entire plant was the "Automatic Railroad," which transferred the material to the mixers. This automatic railway was equipped with electric trolley cars on double trucks, one truck being the driving truck; they were one speed, and without controllers. The cars were started or stopped by throwing or pulling a switch on the side of the car, and laborers were located at points where the cars were liable to become congested to control them. The cars were of steel with hopper bottoms with the capacity of a two yard mixer. The

The Mixing Plant For Gatun.

body of the car was in two compartments, a small one to receive the concrete, a large one to receive the stone and sand.

The mixing plant, located between the storage piles and the locks, is equipped with eight two-yard cube mixers. The car track of the Automatic Railroad runs onto the platform above the mixers, so the cars may be dumped directly into the mixers. The power supply for the operation of the automatic Railroad, the operation of the cranes comes from a large power plant of temporary construction.

The Industrial Railroad is another feature not to be found at any other place in the canal operations. It is an electric narrow gauge railroad, power being supplied from a third rail, and operates between the mixing plants and the cableways. Each train consists of an electric locomotive, capable of various speeds, and two flat cars. The length of the car is the same as the distance between the cableway, and therefore it makes it the most economical to operate the cableway in pairs.

In tracing the material from the time it leaves the places of storage until it is dumped as concrete into the forms, we will follow one of the little electric trolleys on the Automatic Railroad just after leaving the mixing plant. The empty car passes down the long incline, under the side tracks of the Panama Railroad into the cement shed, where it is stopped to receive its portion of cement. Then it passes out the opposite side of the building under the same tracks and turns into a tunnel through the storage piles of sand and rock, where it is again stopped under trapdoors, which allow the proper amount of sand and rock to be placed in the car. It is started again, passes out of the tunnel, up the incline to the receiving platform of the mixing plant and stopped over a hopper leading to one of the mixers. The material is dumped into the mixer, and from the mixer the concrete is dumped into a two-yard bucket on a platform of the Industrial Railroad. The train carries it under the cableways, which deliver the concrete directly into the forms.

From the annual report of the fiscal year ending June 30th, 1912, the eight two-yard mixers furnished 343,364 yards of concrete, were operated daily except Sunday on twelve and nine hour basis. Crushed stone for the concrete of the locks and spillway was obtained from the Porte Bello Quarry until April

30th, 1912, when the crusher plant was shut down, as it was estimated that there was a sufficient quantity in storage to complete the concrete work. The average cost of the rock in the storage piles was $1.43 per cubic yard.

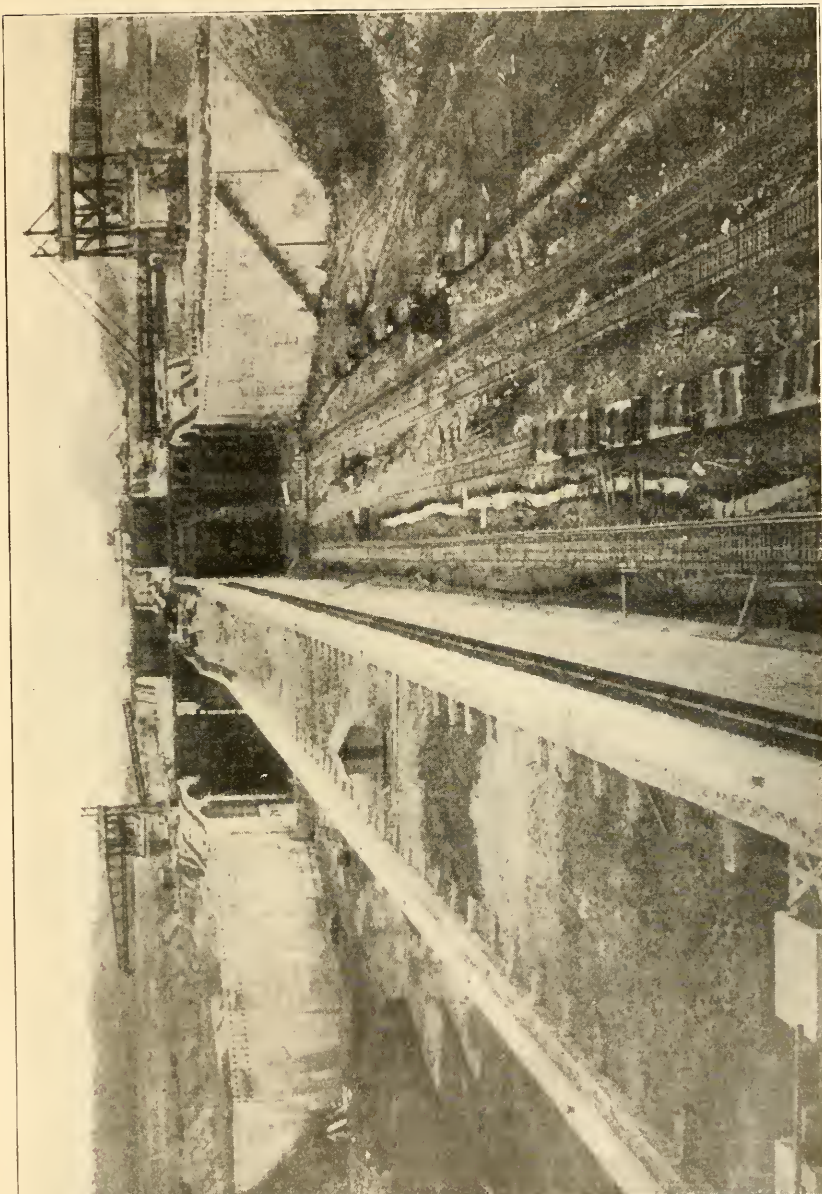
The sand was obtained from Nombre De Dios by use of one of the dredges until November, 1911, when the sand storage pile at Gatun was filled. The cost of the sand per cubic yard in the stock pile was $2.24. The average cost of the plain concrete in place for the Atlantic Diversion was $7.12 per cubic yard. The cement was supplied by various well known cement manufacturers in the United States.

The Mixing Plant for Miraflores.

The materials were handled very nearly in the same manner at Miraflores and Pedro Miguel, but some changes were made at Miraflores which gave it advantages over Pedro Miguel. Miraflores was the last set of locks to be commenced, and in proportion to the yardage, it was completed in less time than either Pedro Miguel or Gatun.

The general scheme was to handle materials through a system of traveling cranes, which would deposit directly into the forms. The storage piles of rock and sand are located about 250 feet from the near side of the locks and parallel to the center line, extending the entire length of the locks. A pile trestle was built and the rock dumped on the side nearest the locks and the sand on the opposite side, the rock coming from the Ancon crusher plant located at the quarries on Ancon Hill and the sand from Chame Point in the Pacific Ocean. By having the storage piles very near the locks, a long haul was eliminated, which reduced the time between mixing and placing and lessened materially the unit cost of the concrete per cubic yard.

The berm crane, located between the locks and the storage piles, is equipped with two cantilever arms, one extending over the storage pile and the other over the lock wall. The arm extending over the storage pile was equipped with a 2½-yard Hullett excavating bucket, while the other carried a two-yard cement bucket. The mixers and temporary cement store room were located on the crane, so that each crane was a complete unit. The cement was brought to the cranes in cars from the main store house and unloaded onto an endless chain elevator, raising it to the elevation of the mixing platform above the mix-



Miraflores Lower Locks. South Guide Wall, Looking North, June, 1913.

ers. The mixers dumped into buckets on a movable platform, which was so arranged as not to necessitate the moving of the buckets on it. The wet concrete was then carried out and deposited directly into the forms, and the cranes were always located so the delivering arm extended over the forms ready for concrete. The berm cranes placed all of the concrete in the side walls.

All of the concrete for the center wall was mixed in two auxiliary mixing plants located in the side wall, one on the upper level and the other on the lower level. All the materials had to be hauled to the auxiliary plants in cars, which was one disadvantage of the plant. The concrete was delivered from the auxiliary mixers to the chamber cranes by a narrow gauge steam railway operating over tracks laid on the lock floors. The concrete was then lifted from the cars by the cranes and deposited directly into the forms. The chamber cranes were used only for the construction of the center wall, although the short arm did reach over the side wall for emergency cases.

In the construction of the locks at Miraflores there were four berm cranes, two on each side of the locks, and four chamber cranes used in the construction, two on each level. The berm cranes were so designed that with a few changes they could be utilized on the new concrete docks at Balboa in the unloading of cargoes of ocean steamers.

The average cost of the plain concrete for the year 1911 was $4.58 for the Pacific Division, in comparison with $7.12 for the Atlantic Division, and reinforced was $10.63 per cubic yard. The average daily capacity for all the plants of the Pacific Division was about 2500 cubic yards.

* * *

National Tube Company, of Pittsburgh, Penna., has ready for distribution a reprint of a paper read before the annual meeting of the American Society of Heating and Ventilating Engineers entitled, "Prevention of Corrosion in Pipe," by F. N. Speller, of Pittsburgh. It is fully illustrated and the company will be glad to supply copies to any of the readers that may be interested.

CONSTRUCTION AND OPERATION OF THE DEERING SOUTHWESTERN RAILWAY. SOUTHWESTERN RY.

BY W. I. CONVERSE.

Chief Engineer of Railways of International Harvester Company. Former Engineer of Construction and Superintendent of Deering Southwestern Railway.

DESCRIPTIVE.

In July, 1910, the first preliminary work was commenced on the construction of two extensions of the Deering Southwestern Railway. Reference to the map will show the general location of this railway in regard to the Mississippi River, Memphis, Cairo, and connecting lines. At that time this railway was a small logging road, extending in a southwesterly direction about ten miles to Hickory Junction, where the various lumber spurs of the Wisconsin Lumber Company branched off over their 60,000 acres of timber land. There was a connection with the St. L. & S. F. R. R. (Frisco Line) near Deering, by which the output of the saw mill at Deering moved via Pascola to Hayti, a main line point. On account of the general bad condition and unsatisfactory service of this Pascola branch line, and the desire of the people in the community to get in closer touch with Caruthersville and the River, the Caruthersville Extension had long been advocated. In this way connection would be made with the Frisco main line just south of Hayti, thus affording a better outlet for the business of this territory.

The country west of Deering was undeveloped and consisted almost entirely of timber land. This country is quite low. Deering being fourteen feet lower than Caruthersville. East of Deering the land is quite well developed and given over to raising of cotton, corn and alfalfa, and produces excellent crops on account of the rich alluvial nature of the soil. This country was formerly subject to yearly overflows and at certain seasons of the year was almost entirely covered by water. It is now, however, protected by levees and the numerous swamps, bayous and lakes have been drained by a system of ditches thirty to eighty feet wide which run in a general southwesterly direction and empty into Little River or the Saint Francis Basin. The low

and swampy condition of this country is attributed largely to the New Madrid Earthquake of 1812. Violent tremors were felt throughout almost this entire year, some being sufficient to cause the Mississippi to run northward, and cause deep fissures in the ground which later became lakes, and the throwing up of long ridges of red sand. Aside from these depressions and ridges, generally lying in a northeasterly and southwesterly direction, the country is practically an alluvial plain, with a slight fall from the Mississippi River westward.

On account of this level condition the grade did not need to exceed ten feet in height and averaged about three feet, with practically no cuts. Particular attention, however, had to be given to drainage of the roadbed and the excessive rainfalls which often occurs must be carried away quickly. The soil is largely gumbo, with stretches of rich black loam and "buckshot," with occasional "sand blows" or pockets of sand. From Braggadocia westward it is practically all gumbo.

SURVEYS.

The plan was to build the Caruthersville Extension from Deering, rehabilitate the old line and later build an extension to Hornersville to connect with the St. L. & S. W. Ry. (Cotton Belt Route), and thus afford another outlet. On account of the donation of various parcels of right of way, the general route was defined, so that a reconnoisance was unnecessary. However, a preliminary line was run to get the location of the section corners and other features. This work started July 5th, 1910, in Caruthersville, where the line was laid out following the directions of a city ordinance already passed. The real preliminary started at Deering and proceeded eastward. This land was surveyed by the Government in 1848, when it was covered with heavy timber and water, so it was found that no three of the section corners were on a straight line and that the sections varied considerably in width. However, most of the original corners were found and they were taken to be correct. From this survey it was found that certain small changes in the proposed route must be made in order to obtain right of way without too much cost and trouble, and in order to avoid certain dwellings and roads and take advantage of parcels donated.

A location survey was then started, again from Deering, cen-

ter line and right of way stakes being accurately placed and hubs tied to section corners, and all curves staked out. The two curves east of Deering were 3° curves, and all the rest were 1° until within the city of Caruthersville, where it was necessary to put in several sharper curves. From this survey descriptions of the right of way parcels were made and deeds prepared. The level party followed the location party and took especial notice of draining roadbed, probable height of high water, etc. Cross sectioning followed this work; in most places level sections could be assumed with slight error. After blasting, stump holes were measured or estimated and noted in the cross section books. From the notes a right of way map was prepared on a scale of 400 feet to the inch and a copy of this and the profile was filed with the county clerk and then everything was in readiness for actual construction, although later it was necessary to obtain certain parcels of right of way by condemnation. These surveys and compilation of notes and maps required about forty days.

CLEARING AND GRADING.

It was decided to let contracts for clearing and grading locally to farmers and others instead of giving the whole to a general contractor. Accordingly specifications and contracts were prepared and bids advertised for. The grading was let at an average price of 15c per cubic yard in cleared land and 18c in timber land. Some especially difficult pieces cost 17½c and 20c. The clearing cost $25 to $35 per acre for cutting and dragging off all timber and underbrush. The stumps were blasted by the company by the day, dynamite costing 15c per pound, dynamiters, $2.00 to $2.50 per day and helpers, $1.50 and $1.75. All stumps were removed from the right of way and ditches. The right of way was in general 50 feet wide. The roadbed was to be 16 feet wide at the crown, with slopes of 1½ to 1 and a berm of three feet. On account of the narrow right of way, considerable difficulty was encountered in some places in getting sufficient dirt and crown was reduced to 14 feet and in other places borrow rights were secured.

In the woods between Braggadocia and Deering, where the timber was very heavy and the soil mostly gumbo, it was impossible to make any headway with teams and slips. A num-

ber of "station men" were employed to put this dump up with wheelbarrows and shovels. Small tents $9\frac{1}{2}$x12 were procured and issued to the station men or "humpers," they supplying their own bedding and cooking utensils and "living on the job." Each man was given one or more stations at 20c per yard, the company furnishing long handled shovels, wheelbarrows and running boards. These men were quite experienced in this kind of work and put up 25 to 30 yards of dump per day, more than a team of horses could do in that kind of ground. Twenty per cent was allowed for shrinkage on account of the loose character of the fill. Over two miles of roadbed was constructed in this manner.

Road-bed Through a Cotton Field.

At times as many as 30 station men and ten grading outfits were working on the dump. This letting of contracts locally had the advantage of having the work go on in a number of places at one time, but rendered supervision more difficult. Estimates were made on the 15th and last day of the month and payments made on the 20th and 5th. Local labor was rather uncertain, it being almost impossible to get work done on Saturday, and layoffs were common. In general open ditches were required along both sides of the right of way, and no deep borrow pits were allowed except in a few necessary places. In places it was necessary to dig a ditch with three foot bottom across country for one-fourth or one-half mile to a country drainage ditch in order that the roadbed would be properly maintained. In Sep-

tember, 1910, a heavy rain of thirteen inches in three days washed some of the new roadbed considerably and filled borrow pits with water, delaying the work about thirty days.

It was necessary to remove eleven buildings of various sizes, consisting of dwellings, barns, outhouses and one brick building. The latter was torn down and hauled by wheelers and put in a heavy fill. Most of the buildings were removed by contract, but some were handled on force account, cost plus 10 per cent. In one place it was necessary to remove one-half mile of hedge about twenty feet high. This was cut down and the larger parts made into fence posts and the remainder piled and burned.

A "Humper's" Camp.

The roots, all of which came in the line of the side ditch, were blown out by a stick of dynamite placed every four feet. The fence posts were used along the right of way and, while small, were very hard and durable.

TRACK LAYING AND SURFACING.

Track laying began in October, 1910, at Deering. Four specially constructed logging cars carried the steel. These cars were twenty feet long and each had two bunks ten feet apart. Steel rollers were placed on the sides of the bunks, forming an incline, so that the rails could be handled easily by rolling them

forward past the end of the cars. The crew usually consisted of twenty-five or thirty men and one foreman, as follows: four spikers, two nippers, two liners, one strapper, eight or twelve tie carriers, two tie handlers on car, two men distributing spikes, bolts and anglebars, and two spikers, one nipper and one bolter following the main gang. Negroes usually composed the front crew, handling the steel and spiking every other tie, the rear gang following behind the train and full spiking and bolting. Spikers received 20c per hour, foreman 30c and other laborers $17\frac{1}{2}$c. The lineup of the train from the front was four steel cars, two tie cars, a shelter car carrying tools, and then the locomotive.

All of the steel was 75# and 80#, some of the former being new first quality thirty-three foot rails, standard A S C E section, drilled for four hole angle bars with 7/8″ bolts. The rest of it was relayer steel with various punchings; the ties were standard 6′x8″-8′ cypress. Under good conditions one-half mile of steel could be loaded and laid in one day, but this record was not often made, especially after the work progressed a few miles from camp. Removing angle bars from relayer rail, derailments, frozen ties, etc., kept the average down to about 2,000 feet.

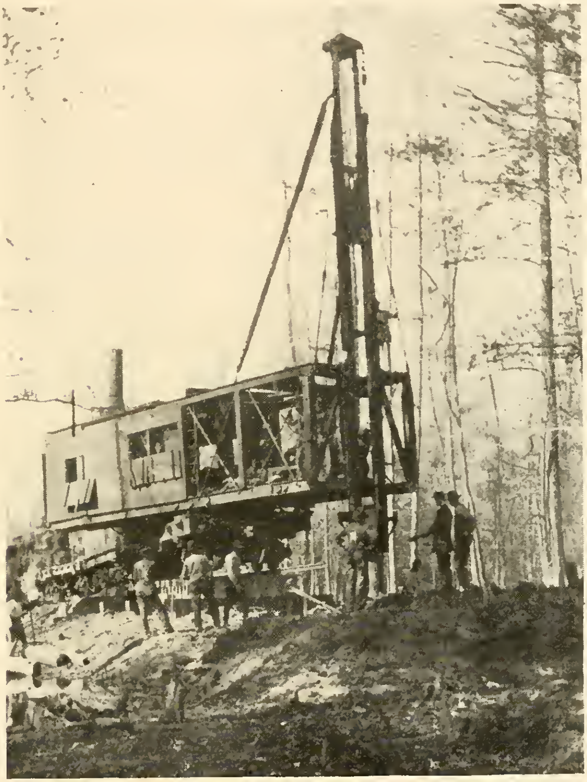
Boarding cars were not used, but a camp was maintained near Deering. This consisted of an office tent 16x20, mess tent 18x30, and bunk tent 18x35. Smaller tents $9\frac{1}{2}$x12 were used for officers' mess, commissary, cooks and foremen. The large mess tent was divided into a kitchen and a dining room with two long tables. Bunk tent had double decked bunks along each side, each bunk containing mattress, blankets, comforts, etc., and accommodating two men.

One or two gangs of six or eight men under "straw bosses" were usually busy surfacing track and keeping it in condition for the work train. When track laying was stopped for bridge work the steel gang was engaged in surfacing. To hasten the work, material was shipped via Frisco to Caruthersville, and two miles of track were laid from that end. The last steel was laid Feb. 28th, 1911.

BRIDGES AND CULVERTS.

Four bridges were built on this extension, two of these being

on a three degree curve one mile east of Deering and together were over 1,000 feet long. These crossed a slough and drainage ditch. The other two bridges were over 100 feet each in length and crossed other drainage ditches. These were all pile trestles, four piles to the bent, caps 12″x12″x14′, stringers 10″x14″x14′, ties 7″x9″x8′, guard rails 6″8″. A maximum su-



Driving the First Trestle.

perelevation of 3″ was allowed on the curve bridges. The pile driver used was an ordinary drop hammer type with a hammer weighing 2,800 pounds. Piling were cypress, twenty-six feet long, although a few 35 foot piling were used. On an average four panels fourteen feet long were driven and capped in a day with a crew of about fifteen men, but sometimes as many as six panels were completed in ten hours.

Culverts were 20″ and 30′ cast iron pipe in twelve foot lengths. Several hundred feet of such pipe were used. Vitrified pipe of 30′ diameter were used for farm crossings and some roadways.

BALLASTING.

A good deal of track could be surfaced in place with sand, but where there was gumbo, sand was of no avail, as the track would sink down to the top of the rail, and sometimes nearly out of sight. In these places a ballast of "silica," a cementing gravel, was used. This was procured from a pit near Cape Girardeau, Mo., and was handled in side door ballast cars with end aprons. A Lidgerwood unloader and plow was used and about fifteen cars could be unloaded at a time. Some 300 cars were used, the "silica" being put 6″ to 8″ under the ties. Track properly ballasted with "silica" required little maintenance and grass did not grow very readily and this ballast did not allow the track to settle into the gumbo. The "silica" was well crowned in the center and sloped out, leaving the bottom of the ties free to drain, thus forming a mat over the gumbo that water will not permeate and through which the gumbo will not work.

FENCING, CROSSINGS AND SIGNS.

The fencing for the most part consisted of 6″ and 12″ electric welded wire fencing 32″ high, with two or three strands of heavy barb wire on seven foot cedar posts sixteen feet apart. Some catalpa, cypress and osage posts were also used. The cattle guards were a form of metal surface guards, in four sections. These guards were not altogether a success, since hogs and cattle will sometimes go over them. In some places wooden pit guards were used, but on account of there being free range for stock in all highways and unfenced land, there was considerable trouble keeping stock off the right of way. Whitewashing wing fences and digging pits two feet wide and two feet deep in front of the metal guards made some improvement.

Farm and road crossings were in general constructed of dirt or silica fill over 30″ sewer pipe, so that drainage would not be affected; twelve foot steel frame and wire farm gates were provided; 3″ planking was used on the ties.

All sign boards were constructed of dressed white oak and parts to be placed in the ground were painted with hot asphaltic paint. These signs included whistle posts, crossing signs, right of way and property signs, danger signs, bridge numbers, mile

posts, station and telephone signs. Bulletin boards were placed at all stations, showing train numbers, time due, etc.

BUILDINGS.

The station buildings were erected by contract. They varied somewhat in design, but were of frame construction, providing waiting room, ticket office and freight room. There were also built by company forces a car repair shop, coal bunkers, water tank, pump house, section houses, telephone booths, outbuildings, etc. A 40 foot 200 ton track scale was placed on concrete foundation at Deering and beam house constructed. Plans were also drawn up for a two stall engine house, machine shop and storeroom, but construction was postponed.

TELEPHONE LINE.

Train dispatching was done by telephone on a line built during the track construction. This was a metallic circuit of twelve gauge galvanized wire on six-pine fir cross arms. The poles, thirty to the mile, are white cedar, twenty-five feet long with 5½″ top and stocky butt. Cypress poles could have been obtained along the line somewhat cheaper, but they deteriorate so rapidly in that soil and climate that they are unsafe to climb within three years. Standard galvanized bolts, washers and braces were used with Strombaugh anchors on curves. At every blind siding and at every two miles along the line insulated leads were taken from the wires to jack boxes placed on the pole. All trains were equipped with portable telephone boxes, so that the crew could plug in at any jack box and call up the dispatcher in case of trouble, or for orders. This was found to be the means of saving considerable time in work and wreck train service and also in ordinary service, on account of having a large number of blind sidings and spurs.

OPERATION.

Surfacing and ballasting progressed so well that the Caruthersville Extension was opened for general business April 3rd, 1911, nine months after the first survey was made. Two trains each way daily were operated between Deering and Caruthersville, and a logging train made two trips from Deering to Hickory Junction. Then ensued work of preparing tariffs and time tables and developing business for the road. At Braggadocia the line ran through a cotton field one-half mile from a small village. Soon

two stores were erected, then a number of dwellings and later a cotton gin. The following season saw another cotton gin at Tindle and spurs nearly every mile, which provided a small but encouraging business of forest products, corn and stock. The duties of a superintendent thus covered the development of good will and acquisition of new business, as well as the usual duties of operation and maintenance.

HORNERSVILLE EXTENSION.

The next problem was to rehabilitate the old line in preparation for the Hornersville Extension. This required "silica" ballast, plenty of trees and a general resurfacing of nearly seven miles of track, besides the rebuilding of several timber bridges. In the fall of 1910 track had been laid from Hickory Junction to Converse, where the Lumber Company had put in a new set of spurs by which they expected to provide a ten years' supply of timber for their mill. From Gobler south for ten miles there runs a fifty foot drainage ditch, dug a few years previously by dredge boats by the lumber company and emptying into Little River about one mile northeast of Hornersville Junction. The spoil from this ditch had been thrown mostly on the south side and in 1910 had been nearly all levelled off to provide a roadbed for the railway. This soil was practically all gumbo and formed a dump averaging six feet high. Most of this leveling had been done by station men, so that in some places it was firm and in others yielding. The first work, therefore, was to ballast this new track from Hickory Junction to Converse. The track was of good 75# and 80# relayer and had been used only a few months by light log trains, but on account of the soft nature of the sub-grade, was in a very bad condition. However, 100 cars of "silica" ballast were used and the track was in good condition by July, 1911.

TRACK LAYING.

Track laying was then started from Converse south. Here, as before, 75# relayer was used and the track-laying was handled in much the same manner as on the Caruthersville Extension. However, the former work had been done in the winter and aside from the spikers and steel handlers most of the laborers were "hoboes." Now with the coming of warm weather the "hoboes" left like rats from a burning ship and it was necessary

to import negroes, getting them from labor agencies at Memphis. The camp was established one mile north of Converse, but now was enlarged to take care of train crews and a larger bridge gang.

BRIDGES.

The track laying here was very much delayed on account of the frequent bridges, there being in a distance of six miles twelve trestles ranking from 28 ft. to 950 ft. in length. This great number of openings was left on account of the swampy character of the soil and the liability to overflows, and future developments proved there were none too many. The type of trestle was the same as used on the Caruthersville extension, except that most of the stringers and caps were long leaf yellow pine instead of cypress. Owing to the extremely hot weather, great difficulty was experienced in keeping laborers, especially white laborers, for the bridgework. Malaria, chills and fever had to be fought, as well as mosquitoes, "chiggers" and snakes. On some of the very hot days the bridge gang could only work early in the morning and late in the evening and in half-hour intervals during the heat of the day. Water for drinking purposes was all boiled and filtered and well iced, and into it was put lemons and rolled oats. Even so, an average of four panels were driven and framed per day. A few of the bridges were framed on mud sills before the pile driver arrived.

BALLASTING.

Ballasting was carried on as fast as possible after the track laying, 100 cars of silica being used, but even then the track got into very bad condition on account of the extremely soft nature of the gumbo sub grade, which would bake hard on top, but six inches under the surface would be as soft as putty. In many places all that could be done was to put saplings or ties lengthwise under the ends of the ties. A shallow sand pit was also opened up near Deering and worked by means of an old log loader and orange peel bucket, and nearly a hundred cars of sand were used for ballast. But the sand did very little good, since the gumbo worked up through it and the track soon sunk down out of surface. A few slides along the ditch bank also appeared and it was necessary to drive piling about four feet apart and build a bulkhead of two-inch plank.

OPERATION.

By December connection had been made with the Cotton Belt System at Hornersville Junction, on the east side of Little River, and from there entrance was had to Hornersville over a trestle 4,000 feet long. A "Y" and coal bunkers had also been built at Hornersville and arrangements made for a joint agency. On December 17th, 1911, the line was opened for general traffic, there being one train each way between Hornersville and Deering and two trains each way between Deering and Caruthersville, besides a log train making two round trips daily between Deering and Converse. Later the service was extended to a passen-

Cleared Right of Way After a 15-in. Rainfall.

ger train making two round trips daily between Hornersville and Caruthersville and a local freight train making a round trip between Deering and Caruthersville and then making two long trips for logs from Deering to Converse.

FLOODS.

The mean annual rainfall in this district is about 45″ and therefore often causes considerable trouble, especially during the flood periods of the Mississippi River. In April, 1912, on account of a break in the Mississippi levee opposite Tiptonville, Tennessee, the flood waters came back into Little River valley and inundated the Railway from Braggadocia to Hornersville. At that time the writer made a trip along the right of way from

Deering to Hornersville in a skiff. After the water receded, it was found that about ten miles of track was washed out more or less, in some places being entirely off the roadbed. It required some 30,000 yards of filling and nearly 500 feet of new trestles to put the road back into operation. As soon as possible a work train was loaded up with ties and timbers and many of the openings were cribbed in this way. In other places trees were cut down and used for cribbing. In one place a whole 30 feet deep and 60 feet wide had been washed out where there had been a 14-foot bridge. Two long cypress trees were cut and used

Flood Repair Work.

for stringers, being placed on timber mud sills on each bank. Three frame bents were made and sunk under the bridge and jacked down into the mud and the whole guyed to trees by $\frac{7}{8}''$ wire cables. This bridge was used for several weeks while waiting to get a pile driver.

In January, 1913, on account of heavy rains near Cape Girardeau the track at Deering was inundated again, but trains continued to run, though often through 12 to 15 inches of water. In April, 1913, another Mississippi flood came, higher than any previous one, and again the tracks were covered, but this time by using work trains day and night, staking and wiring back to

trees, sandbagging and cribbing, a good deal of the track was saved and service was resumed after the water receded.

The general direction of the Deering Southwestern Ry. being east and west is, of course, directly opposed to the flow of flood water from the north, and in spite of the many openings, especially in the lowest part of the line, high waters will of course do considerable damage. In one place the water was three feet from the top of a bridge and at Deering was generally one foot over the top of the rail. Even with sufficient levee protection, which now seems feasible, it appears that floods are to be expected on account of the heavy rainfalls and the extent of the Little River Basin. A scheme of drainage of the Little River Basin is now under way and it is expected that eventually this water will be confined to a 200 foot channel, a large part of the water shed drainage being diverted directly to the Mississippi River by means of levees and by-passes near Cape Girardeau. Probably, then, this problem will be solved and millions of dollars will be saved ot the railroads in this territory.

E. E. White, Ishpeming, Mich. has issued a folder describing the Maas drill hole compass for determining the direction and dip of drill holes. This compass is placed in a thermos bottle or glass tube with hot liquid gelatine and lowered in a watertight phosphor bronze case, with a tube containing hydrofluoric acid. When the gelatine is cold the rods are pulled, the direction of the needle is marked on the tube which contained the acid and the direction and inclination of the hole determined from this tube in a gniometer. This compass, it is claimed, will survey drill holes to a depth of 3,000 feet for both direction and inclination. Mr. White is American agent for this compass and has rented a number of the devices to exploring companies in the United States.

ELEVATORS

BY ALEXANDER H. BOEHMER.

Class of 1907, Armour Institute of Technology.

The object of this article will be to briefly describe the different classes of elevators and enumerate a few of the more prominent safety features now used in conjunction with the higher types of electric elevators. A description of the technical points in the construction or operation of elevators will not be attempted.

Elevators of course could be classified under freight or passenger elevators or a combination of both. Or they could also be divided into power elevators or manually operated elevators. The easier and at the same time better method of classification will be to divide them the latter way.

Power elevators can be classified according to their source of power, which in the order of their development will be steam, hydraulic and electric elevators. The different types of elevators will be described in this way.

The Steam elevator at the present time is practically obsolete, no new installation of any size having been made in recent years. However, there are still quite a few steam operated elevators in actual service.

Hydraulic elevators are of two different types, which for convenience we may call the plunger and the piston elevator. In the plunger elevator the hydraulic pressure is applied to a plunger directly beneath the platform. The water pressure raises the plunger which lifts the platform and load. In lowering the elevator the water is discharged either into the drain or back into a tank or reservoir. In the piston type of hydraulic elevator, the water pressure is applied to a piston in a cylinder. The piston rod is applied with moving sheaves and the cylinder with fixed sheaves around which pass the hoisting ropes. One end of the hoisting rope is anchored to the machine and the other to the car. The movement of the piston is in this way transmitted to the elevator. A great variety of combinations of gearing can be obtained by varying the number of sheaves. This piston type of hydraulic elevator can be either vertical or horizontal.

Many installations of both the plunger and piston types have

been made, but the great advancement of recent years made in the application of electricity to elevator work has caused the electric elevator to practically supersede the hydraulic installation. There are still a great many engineers who prefer the hydraulic elevator, especially for isolated plants where there are a number of elevators. A plunger installation of any size requires the installing of a pumping plant to obtain the required pressure for operation, which makes the first cost of a plant rather high compared to the electrical installation. Small hydraulic elevators upon which the service is not severe and the cost of water not very great so that city pressure can be used are very desirable in many places.

Electric elevators, broadly speaking, are of three different types, namely—drum machines, traction machines and hydropneumatic plants. This latter class, however, cannot strictly be called an electric elevator, although the primary source of power for the elevator is electrical. A description of this type will be made later.

In the drum machine the hoisting ropes are fastened to a drum and wound around this drum in lifting the elevator, whereas in the traction type of elevators the ropes pass over a sheave and the load lifted by means of the traction between the revolving sheave and the ropes.

The simplest and least expensive of the drum machines is the belt driven elevator. In the double belt machine, the drum is driven from a line shaft or counter shaft in the building by means of belts and the speed reduced through a worm and gear in the machine. Two belts, one a crossed belt for reversing the machine, operate on loose pulleys on the machine. Either one of these belts can be shifted onto the tight or driving pulley of the machine by means of a hand cable in the hatchway. This type of elevator requires that the line shaft or counter shaft be in motion at all times.

On a single belt elevator, the belt runs from a motor to the machine or from a counter shaft which is driven by a motor to the machine and the control of the elevator obtained through a hand cable which starts the motor either forward or reverse. In this type of machine, power is consumed only while the elevator is in operation.

The least expensive type of direct connected machine is the ceiling type. In this machine the drum is driven directly from the motor through a worm and gear and the entire machine suspended from a ceiling in the building. This machine is operated by means of a hand cable in the hatchway which throws the electrical circuit in one direction or the other obtaining either ascending or descending motion.

The highest and most commonly used type of drum machine is that in which the motor and drum are mounted upon one bedplate. This machine is usually placed on a foundation at the lowest landing or upon beams and floor above the hatchway, although in some cases the machine is mounted on an intermediate floor. A relatively high speed motor is used with this type of machine, varying of course with the car speed desired and the current characteristic of the power circuit. A great variety of car speeds can be obtained through the use of different speed motors, different gear combinations and different drum diameters.

Many high class installations have been made with this type of machine, the refinement of the machine varying with the class of installation. With this type of machine, the high speed required of elevators in modern buildings was not available and the drum machine was therefore superseded by the traction machine as building conditions required high speed elevators.

The highest type of electric elevator today is the Traction Machine. The elevator car with its load is lifted by means of the friction obtained between the ropes and a driving sheave. By referring to the illustrations it will be noted that one end of the hoisting ropes is fastened to the car frame and the rope passes first over a driving sheave which has straight grooves and then over an idler sheave with straight grooves, back again with another half turn around the driving sheave and then again over the idler sheave and to the counter weight. The traction effect between the ropes and the driving sheave is sufficient to lift the load when the proper amount of counter weight is used. Exhaustive experiments have shown that there is very little slippage between the ropes and the driving sheave. The driving sheave is connected either directly to the motor or through gears. Thus there are two types of traction elevators, the gearless and the

geared type. The geared type of machine is of two different kinds, either worm and gear or herringbone gear and pinion.

The geared traction machine uses a high speed motor and is applicable for installations of relatively lower car speed, and where the service conditions are not so severe as to warrant the expense of a gearless traction installation. The speed reduction of this class of machine is obtained in the same manner as in the drum machine. The machine with worm and gear is more suitable for slow speed cars than is the herringbone geared machine as speed reduction is more easily obtained with worm and gear. The herringbone gear machine is used for comparatively high speed elevators, but it is not as sufficient as the gearless machine. The herringbone machine is, however, more efficient than the worm and gear machine, but the worm and gear machine has the lesser tendency to vibrate.

Undoubtedly the highest type of elevator as well as the most efficient is the gearless traction. This machine uses a slow speed motor, the speed of the motor varying in different machines from about 50 to 85 or 90 R. P. M. Recent developments of electric motors has proven that a slow speed motor of moderate duty can be constructed to give a very high efficiency. Experiments have shown that the efficiency of this type of motor is also very high at light loads, which is very advantageous in elevator work as the ordinary service of an elevator is very much less than its maximum requirements.

Gearless traction machines are usually equipped with anti-friction type of bearings, either ball or roller bearings. The reasons for this are both to gain efficiency by reducing friction, also to gain space by reducing the overall length of the machine. The saving due to the reduction of friction is greater and practically a necessity, where 2:1 roping is used. In Fig. 1 is shown the 1:1 method of roping a traction elevator and Fig. 2 shows the 2:1 method of roping. From the illustration it is plainly seen that the 2:1 roping can be used with higher speed motors than the 1:1. It can also be seen that heavier loads can be lifted with a smaller motor, but of course this is at the sacrifice of speed.

The amount of counter weight used has been determined from experiments and tests. This is usually equal to the total weight of the car frame and car plus forty per cent (40%) of the rated load of the elevator. This forty per cent of the load is known as

the over balance and is practically equal to the average load of the elevator. Thus it will be seen that in lifting the average load, power is necessary only to accelerate the load and overcome friction, the counterweight lifting the load.

By referring to the illustration, it will be noted that especially in high rise elevators, the load on the car side when the car is down will be considerable more than when the car is up on account of the weight of the cables. This is overcome by the introduction of compensating ropes or chains. The usual method of compensation is as shown in Fig. 1 where the one end of the compensating ropes are fastened to the under side of the car frame and the other end to the under side of the counter weight. With this arrangement of compensation, the load is practically the same whatever the position of the car, the only difference being due to the conductor cables which hang between the bottom of the car and the walls of the hatchway. Provision is made for taking care of the slack of these compensating cables by arranging the compensating rope sheave in the pit in slots so that it will always keep these ropes tight.

All traction machines are provided with oil buffers which bring either the car or the counter weight to a gradual stop at the lower landing. When either the car or the counterweight rests upon the buffer the ropes of course become slack and friction between the driving sheave and the ropes is destroyed. This obviously is a great safety feature in this type of machine. These buffers will stop a fully loaded car descending at a speed fifty per cent (50%) in excess of rated speed without discomfort to the passengers.

Some of the safety features found in the more common installations of traction machine may be enumerated as follows:

(a) Oil buffers mentioned above.

(b) Limit switches in the hatchway for cutting off the current supply.

(c) Automatic stopping switches on the car which automatically stop the elevator at terminal landings.

(d) Automatic return of the car switch to "off position" when the handle is released.

(e) Centrifugal governor which bears a switch that cuts off power from the machine and applies a brake to the machine

and then sets the safety underneath the car which grips the guide rails.

(f) A safety switch in the car which is under control of the operator and which also cuts off the current supply.

One of the first problems arising in the installation of an elevator is the question of the location of the machine. Generally speaking, the better location for the machine is overhead. With the machine overhead the load to be supported by the building is equal to the weight of the machine plus the loads on the ropes, whereas, with the machine in the basement, the load to be supported by the building is equal to twice the loads on the ropes. Ordinarily the machine weighs considerable less than the load on the ropes, and it will therefore be seen that the overhead location does not require as heavy a building construction as the basement location would. Another factor in favor of the overhead location is the fact that the machine in this position utilizes space which would otherwise be wasted instead of taking valuable building space on lower floors. The overhead machine uses less rope, requires less turns and insures longer life of rope.

One of the most recent developments of an inexpensive compact elevator installation is the hydro-pneumatic type. This type of elevator is in reality a plunger elevator with an independent plant to furnish the power. Compressed air is obtained by means of an electric motor and air compressor direct connected. This is usually of the street car type where the motor and compressor are entirely enclosed in a single case. The compressed air is stored in an air tank to which is connected a regulating device which starts the motor when the air pressure is lowered to a predetermined point and which also stops the motor when the pressure reaches a certain predetermined point. By this means there is always a constant supply of air under pressure.

The shifting of the elevator hand rope in one direction opens a valve which admits the air to the fluid reservoir. This operation at the same time opens a valve connecting the fluid reservoir and the elevator cylinder. The pressure of the fluid thus raising the elevator. In lowering the elevator the valve connecting the cylinder and the fluid reservoir is again opened, but connection between the air tank and the fluid reservoir is closed while the fluid reservoir is open to the atmosphere allowing the compressed air remaining in the reservoir to escape, the weight of the elevator

and plunger with the load will force the fluid back into the reservoir. The fluid usually employed in this type of elevator is a cheaper grade of oil and in some cases water, although oil possesses several obvious advantages over water.

An installation of this kind cannot be operated efficiently where intermediate landings are to be served or where the service is very severe, but is a very practical outfit for sidewalk lifts and work of that character. It has the advantage over an ordinary plunger installation as its cost of operation is usually less, especially where water is obtained on metered service. It has the advantage over an electric sidewalk lift in as much as the "plant" does not occupy as large a space as an electric machine and can be placed in any convenient location in the building where it will not be exposed to the weather.

Reliability in an engineer should not be confused with what is commonly called "honesty," which is merely the inclination to do one's best. Reliability is a faculty which requires constant training until mere inclination has been developed into ability to get out of oneself the very best possible from one's mental and physical qualifications. One phase of reliability is the ability to carry out definite instructions. This cannot be done without continual training of the mind, and the lack of such training is shown by the inability or unwillingness of many people to carry out a given piece of work according to given instructions. Another evidence of reliability is a willingness to acknowledge promptly one's inability to carry out a certain piece of work in a prescrbed way or within a specified time limit. Paradoxical as it may seem, a definite statement of what he cannot do may often be the first thing to attract favorable attention to a young man.

—*Fred E. Rogers.*

AUTOMATICALLY CONTROLLED SUBSTATIONS

BY HERMAN N. SIMPSON.

Class of 1916, Electrical Engineering Department, Armour Institute of Technology.

Previous to 1911, all substations containing apparatus for the purpose of the transformation of electricity, other than transformer substations, required attendants to properly control the apparatus. This necessarily limited the methods of operating substations then in use. In 1911 Alexander Dow, President of the Detroit Edison Company, pointed out this limitation and suggested the use of remotely controlled equipments, where one operator, in a central station, could control several different substation apparatus at a distance. Acting on his suggestion, there was installed in one of the substations in Detroit, remote control apparatus, which has operated with entire satisfaction since 1912. The entirely automatically controlled subdivision carries to a final conclusion the interesting ideas involved in the Edison installation at Detroit.

Automatic control, while most admirably adapted for use in railway substations, can be used with advantage elsewhere, but to a lesser extent. It may be used to control converting apparatus, for direct current lighting and power systems, and when so applied the initial operation to place the converter into service can be performed by a contact making time clock, instead of a contact making voltmeter, as the case in railway substation control. Where more than one unit is located in a substation, contact making ammeters would initiate the starting and stopping of second and third machines. The automatic controls, may, with some modifications, be applied also to the control of hydro-electric generating stations, where a large system may be composed of many small and isolated stations.

One of the large railway systems of this country, when it proposed to electrify a mountain division, contemplated the construction of two substations, which would operate only when there was a demand for power. Automatically controlled substations had as yet not been suggested as a possible means of economical operation. The fundamental idea was to save substation equipment, operating at a large overload as the trains

passed the stations, and allowing the converters to coal between trains. The suggestion of automatic control at such a time was a little startling, considering the capacities of the machines involved.

A purely automatic substation may then be defined as one in which the starting and the connecting to the line whenever there is a demand for power, and finally shuting them down after the demand for power has been satisfied, are all performed in their proper time relation, without the assistance of an attendant, in it or adjacent stations. This distinguishes it from a remotely controlled station, with a sepaarte feeder to each machine, which are both started and stopped by an operator in the station from which power is supplied.

Previous to the use of automatic substations, the starting, loading, and shutting down of converters in railway substations was left to the judgment of the attendant. He relied on the ammeters and voltmeters on the control board, to show him whether there was a demand for power, and also for the purpose of timing the starting of the apparatus. Suppose, for instance, that at a certain time, a car is known by the attendant to be due in the section of the line which his substation supplies with power. The operator will note a gradual falling off of the voltage of the line, as the demand for power continues, and the car gets farther and farther away from the source of power. At a certain lower limit of voltage he will start his converter, bring it up to speed and then throw it on the line, direct through a circuit breaker. As the car recedes in the opposite direction he will again depend on the voltmeters and ammeters to tell him when to shut down the machine. These changes in the condition of the electrical circuit, which the attendant observes, can, however, be readily used to operate relays in control circuits, and if the control equipment is made to act automatically the judgment of the attendant is no longer necessary.

If we proceed on the assumption that it is desirable to substitute automatic substations for those in which an attendant is required, it is evident that the design of converting and distributing systems will be affected to some extent by these new conditions. If the substation buildings be designed with particular reference to their ability to house the apparatus, and without any

regard for the welfare of the attendant, who has been dispensed with, it is probable that the cost of a greater number of stations of smaller capacity, will not be any greater than a fewer number of stations designed with a view to meet both of these conditions. The distance between stations under these new conditions being shorter, a direct saving of feeder copper is the result and also a better distribution of load between the converters.

A good illustration of the probable saving of copper in the direct-current system of an interurban electric railway is well obtained by first figuring the amount required on the supposition that a system is designed to use the standard hand operated substations, and then on the supposition that automatically controlled substations, of twice the number, but of the same total capacity, are used.

Using as an illustration a single track road, thirty-two miles long, with forty ton cars, equipped with four, seventy-five horsepower motors, capable of a maximum speed of forty miles per hour and a schedule speed of twenty-four miles per hour, with one stop per mile, a rate of acceleration of one and a tenth miles per hour per second and 70-pound rails and a four zeros trolley wire. Estimating on the assumption of three hand operated 500 kw., 600 volt stations, located twelve miles apart, with four-mile stub end feeds, 262,000 pounds of feeder copper are needed. This does not take into account trolley feeder taps, or sag of the line. Substitute for these three stations, six automatic ones, of 250 kw. capacity, located seven miles apart, with one and a half mile stub-end feeds, we find that no feeder copper in addition to the regular four zeros trolley wire is required. This shows the relation which feeder copper bears to the distance between stations, and shows that the economical limits of the lower voltage trolley systems are considerably increased, provided that the number and location of the substations are not adversely affected on the assumption that attendants are necessary.

High voltage direct current trolley systems are savers of feeder copper and tend to reduce the number of converting stations. Sudden changes in current, however, induce destructive voltages in long feeders and return rail circuits. It is therefore advantageous to reduce the voltage of the system and to increase the number of stations. Along this line it may be well to mention

that the feeder circuits from automatic substations are not opened on overload or short circuit, but are protected by a limiting resistance placed in circuit under such overload or short circuit condition. The current needed to start cars that meet and pass on a siding is often sufficient to open the breakers. The speed and counter e. m. f. of the motors may at such a time conform to an impressed voltage of 200 or less, but when the attendant recloses the breaker the motors are subjected to a voltage of 600, which may cause bad damage or strains in the equipment. The magnitude of these strains are reduced if there is a reasonable amount of resistance in circuit between the cars and the substation. For this reason it is advisable to tap the trolley a short distance on either side of the substation, and thus a small amount of feeder copper is required.

Concentration of traffic does not cause dangerous overloading of the relatively small units used in automatic substations, as the current limiting resistances give a drooping voltage characteristic to the apparatus so exposed, and the demand for power, as shown by this drop in voltage, will automatically start the machines in adjacent stations. The proportion of the load carried by the stations on either side of the one which was overloaded, could be increased if their voltages were raised when they were lightly loaded. Automatic field regulators for motor generator sets, and induction regulators for converters are available for reaching this end.

The time required for the starting and connecting to the line of the machines is also important when we talk about their sharing with adjacent machines, a load which may last but a few minutes. A 500 kw., 25 cycle, synchronous converter, can readily be started from rest and connected to the line in thirty-five seconds and a 300 kw. machine will require but twenty-five seconds for a similar operation. Hand operation, of course, requires a much longer time, and to this must be added the time which it takes for the attendant to observe the conditions on his instrument and conclude that he should start the apparatus.

The choice between motor-generator sets and synchronous converters has heretofore been largely determined by their difference of efficiencies under light loads, but since these light load losses can be saved, the machines being operated under load,

other characteristics govern the selection of converting apparatus. Light load losses are a fairly high percentage of the total kilowatt-hours supplied to substations delivering energy to a system with an infrequent car service. It is estimated that in less than one and a half minutes the energy required to furnish the light load losses would be equal to the energy required to start the machine. This is for a 300 kw., 25 cycle, 600 volt converter. It is astonishing, yet nevertheless true, that on a system using the automatic control, of the total power formerly delivered to the converters thirty-five per cent of this has been saved through the eradication of the no-load losses. This shows the economical advantage of the automatic system.

The writer is indebted for much of the above paper and the following to Messrs. Allen and Taylor, whose paper in the September, 1915, issue of the Proceedings of the A. I. E. E. treated the subject of automatic substations in detail.

Fig. 1.—Substation at Union

The automatic control which will now be described has been in operation in all three substations of the Elgin and Belvidere Electric Railway Company since August, 1915, the station at Union, Illinois, having been equipped with this form of control in December, 1914, for experimental purposes. The railway company operates a standard gauge, single track, 600 volt, interurban railway. Energy is purchased from the Aurora and Elgin and Chicago Railroad at 26,000 volts, three phase, 25 cycles,

and is transformed and converted at each of the substations into direct current at the required voltage. Each substation contains a standard 300 kw., 600 volt, 25 cycle, three phase synchronous converter; three 110 kw. 26,000-370 volt single phase transformers which are oil insulated and self-cooled, a reactance coil, a high tension panel and switching equipment; and three low tension panels.

The automatic equipment, which is wired in multiple with the hand operated equipment, consists of thirty-seven parts, consisting of relays, contractors, switches, etc., which may be divided into six groups. The first group consists of the selective relays,

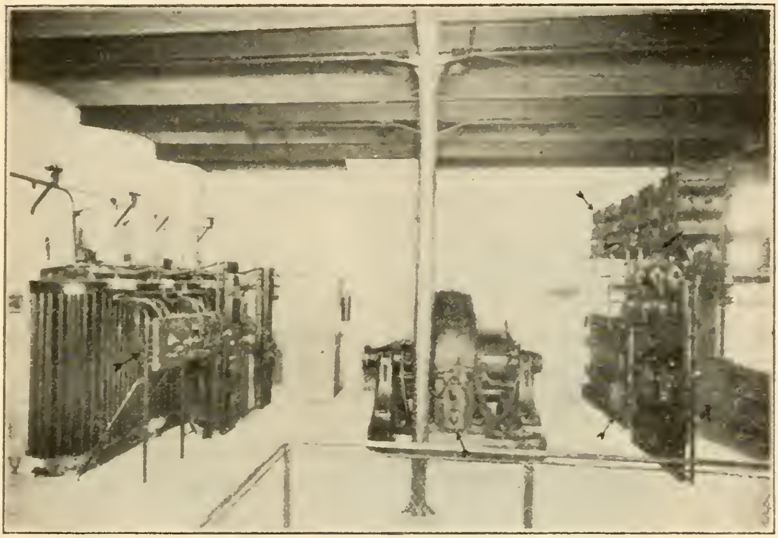


Fig. 2.—Arrows Indicate Automatic Equipment.

which initiate the process of starting and stopping the converter. The second group consists of five relays for stepping up the action of the selective relays. Group three includes a motor-driven drum controller, a small d.-c. exciter and an electrically operated oil switch.. The next set consists of three contactors, which govern the action of the field current. Group five carries the full load current of the converter and consists of six contactors. The last group constitute the protective devices and include an inverse time limit overload relay, a low voltage relay, three instantaneous overload relays, two reverse current relays

and a relay connected to three thermostats, which are located in various parts of the converter.

The contact-making voltmeter, which initiates the process of starting the converter, consists of an electro-magnet permanently connected from the overhead trolley line to the rail. It is provided with a moving plunger, connected to a pivoted contact making arm, which moves between an upper and lower stud depending on the voltage of the line. The arm touches the top stud in the low voltage or open circuit position. The closing of this contact is the initial operation for starting the rotary converter, and it does not leave the stud until the voltage exceeds 500. The lower stud is the cut out position and the movable arm reaches it when the voltage exceeds 600. A dash-pot connected to this voltmeter retards its action about six seconds, preventing it from responding to momentary fluctuations in voltage. Arranged in circuit with the voltmeter is a high resistance, normally short circuited by an auxiliary contact of a current relay. When more than a predetermined amount of current flows through this latter relay, its plunger and auxiliary contacts are raised, removing the short circuit and placing the resistance in series with the voltmeter. This is equivalent to a low voltage condition and the contact arm will keep a position on the upper stud.

We can now follow each device in its proper sequence, through a complete operation of starting, running and stopping the rotary converter. Without going into detail, let us assume that there are no cars operating in the zone of this station, and that the potential of the trolley is between 500 volts and 600 volts. As a car enters the zone, the movable arm of the contact making voltmeter will engage the upper stud, completing a circuit through relays which step up the action of the voltmeter, and cause the drum of a small control motor to operate. As the drum controller revolves it brings the converter up to speed on one-half of the normal a.-c. voltage, and energizes the field to the right polarity. When this action is complete the rotary is thrown directly on the line through a limiting resistance, which is finally cut out by the action of relays, short circuiting parts of it in succession. Full d.-c. voltage is then available at the trolley.

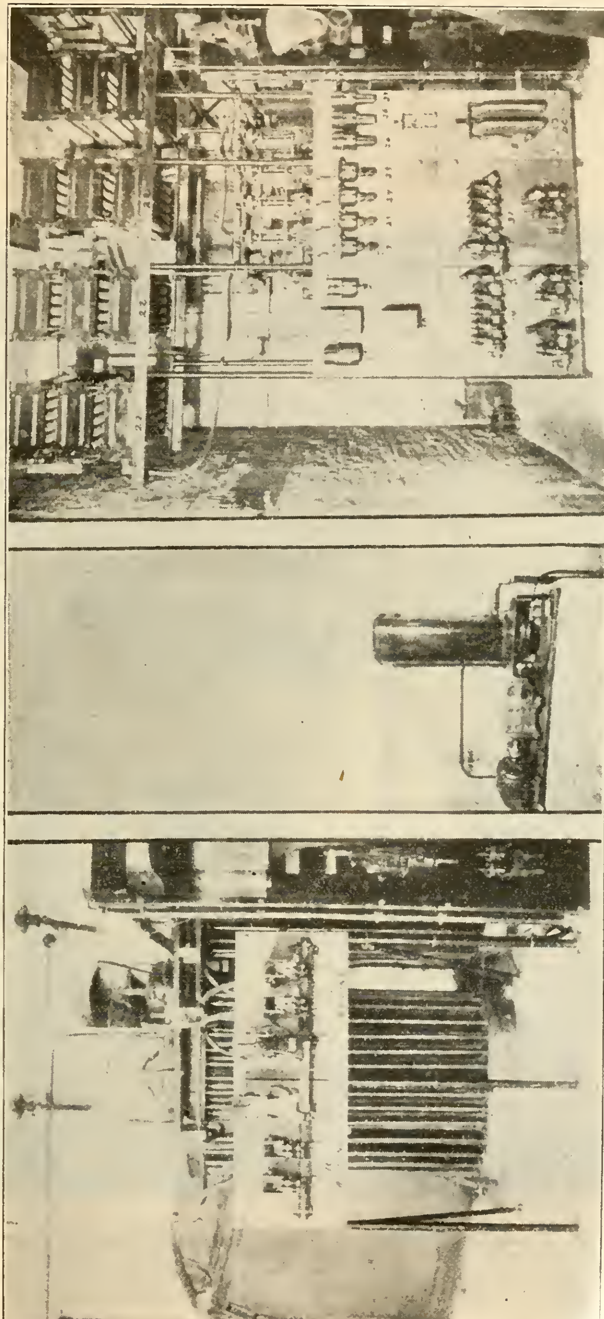


Fig. 3.

Should an overload occur on the d.-c. system, relays would operate, the number operating depending on the amount of overload, placing resistance in circuit between the machine and the line. When load conditions again return to normal the overload

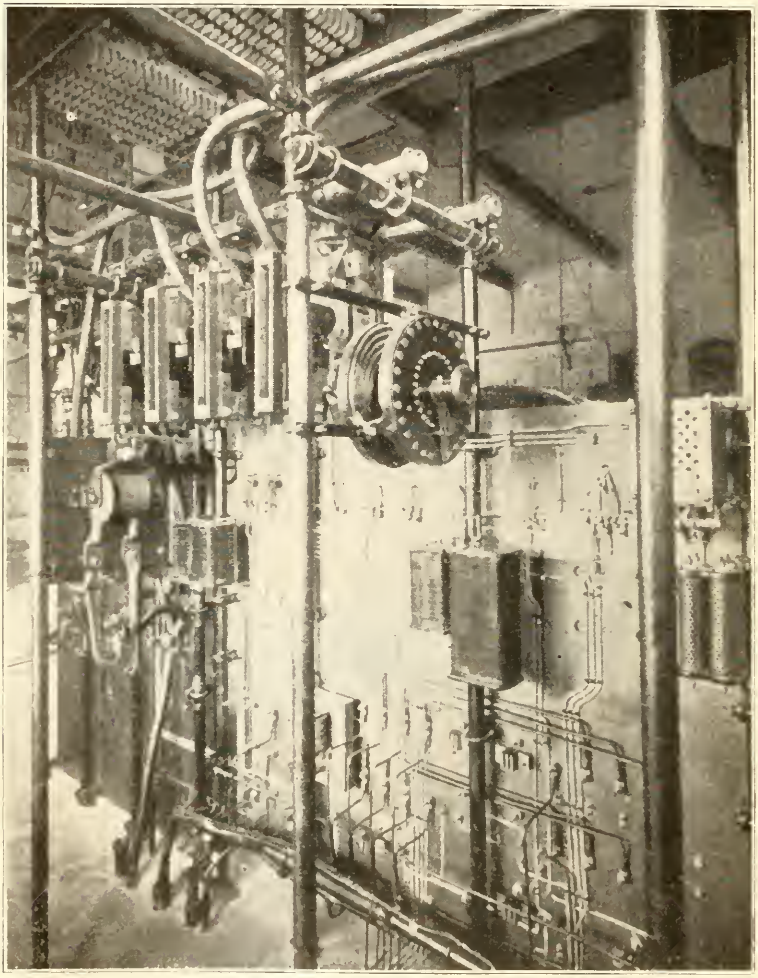


Fig. 4.—Rear of Automatic Panel. Hand-operated Panels at Left Side.

relays would reset themselves automatically. A short circuit in the machine would operate an inverse time limit relay, which in turn, would operate a contactor, dropping the load which is then on the converter.

A low voltage relay, thermostats and a speed regulating device, afford additional protection, dropping a contactor which, through the action of other relays eventually brings the machine to a standstill.

If we assume that conditions have been normal, and that the car, or cars, are leaving the zone of this substation, the voltage of the trolley, being now 600 or more will cause the contact making voltmeter to engage its lower stud, which through a series of relays finally drops out of circuit a master contactor, shutting the converter down. A complete cycle has now been gone through and the apparatus is again ready to function.

There is a large field in the future for the application of some of the principles used in these automatic substations, and it will not be very long before many of our railway systems, which provide a sixty minute or more car service will adopt this economical method of control.

"Insuring the Coal Supply," by Henry J. Esdall, of Philadelphia, is the title of a very instructive story in Book No. 249, provided by the LINK-BELT CO., Philadelphia, Chicago, and Indianapolis. The author deals with the deterioration and spontaneous heating of coal in storage, ample storage facilities for storage, overhead storage for mechanical stokers, conveyors to both store and reclaim coal, pit storage, conveyors cheaper than trestles, weighing hoppers, storage by clamshell and monorail trolley, and Dodge system, with anthracite coal. The various facilities are illustrated and described.

DESIGN OF RETAINING WALLS

By JOHN B. JOHNSON.

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It is not the purpose of this article to give a theoretical discussion of the methods of analysis of concrete retaining walls, for to do so, would be but to invite criticism and argument. All that I shall endeavor to do is to present the method of analysis that has been used in the design of retaining walls for track elevation work for one of the most important railroads of the country, where it was found that the sections so obtained agreed closely with the majority of sections then in use by the best of practice, where security was desired at a minimum of construction cost. No theoretical proof is to be furnished, as this is sufficiently covered in standard text books. A formula only is assured and the method of arranging the work, showing what factors are the determining features of the design.

Three distinct classes of walls are assumed, i. e., walls with no surcharge, walls with partial surcharge and wall with full surcharge. In the first class the earth constrained is level and at the same elevation as the top of the wall. In the second case the earth slopes up from the top of the wall at a slope, assumed at one and a half to one, to a height above the top of the wall not to exceed forty per cent of its height, then running level at that elevation. For the last class, or walls with full surcharge, the earth slopes up from the top of the wall continuing past this point, or as far as we are concerned, indefinitely. A point is reached in designing walls of the second class, as the height of the surcharge increases, where the section obtained agrees very closely with the section obtained as if the wall were analyzed as a wall with full surcharge, or a wall of the third class. This was assumed as the boundary line between these two classes as given above.

In case where we had a narrow restricted right of way, the level of the top of the fill and the top of the retaining wall were at the same elevation and the center line of the track was in close proximity to the face of the wall, hence cognizance must be taken of the live load influence on the design of the section. The live load was assumed as 12,000 pounds per lineal foot of track, distributed over eight feet at the base of rail and spreading uni-

formly through the fill six inches horizontally on each side of the tie for each foot of fill descended. The spread was assumed to continue till the back of the wall was met on one side and the center line between tracks on the other. Vertical planes through these two points parallel with the center line of track outlined the boundaries of the spread of the live load. In case of the walls with partial surcharge this effect decreased as the face of the wall moved out from the center line of track, till in the case of the full surcharged wall, the influence disappeared entirely.

In investigating the effect of the horizontal thrust of the fill Rankines Formula was used for the design of the walls without and with partial surcharge, while Rankines modified formula was used in investigating the full surcharged walls. The angle of repose was assumed as thirty degrees for the walls without or with partial surcharge, and thirty-three degrees forty minutes for walls with full surcharge. This was based on the assumption that the wall with full surcharge was entirely removed from the influence of passing trains and the earth would be in a more coherent condition. Earth was assumed to weigh 100 pounds per cubic foot and concrete 150 pounds per cubic foot.

Each section was analyzed entirely on the theory of securing certain factors against failure. The factor against overturning being assumed at two and the factor against sliding one and a quarter. The latter was assumed at the lower amount as the sheeting was left in place, securing the wall against sliding. All elevations are referred to Chicago City datum as zero, which was about the elevation of the ground water at this location. After the wall was completed the pavement was laid, bringing the elevation of the pavement about six inches above the top of the footings, but no restraining effect was assumed therefrom.

The following computations are perhaps somewhat more complete than would be necessary for an ordinary analysis, in order to fully explain each step to one not familiar with the work. Each step is carried out in full and any one having a conception of the theory of earthwork design should have no difficulty in following them.

Assume:

Live load as 12,000 pounds per foot of track distributed over eight feet of tie and spreading six inches on each side for each foot of fill descended.

Concrete as weighing 150 pounds per cubic foot, and earth as 100 pounds per cubic foot.

The horizontal thrust as one-third of the vertical load.

Standard Mass Section.

DESIGN OF SECTION.

$$\text{Batter of back of wall} = \frac{7.25}{17} = .426 \text{ ft. per foot}$$

Spread of live load .500 ft. per foot

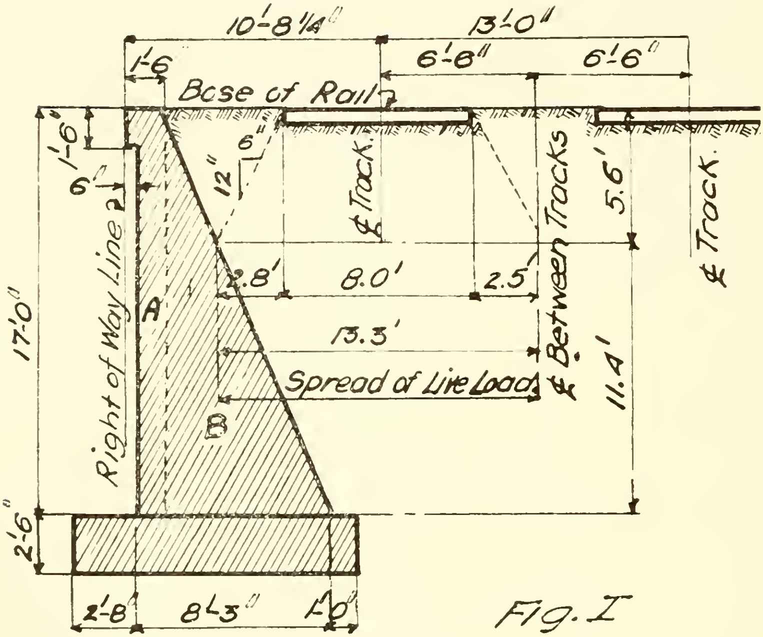


Fig. I

Total convergence of live load spread and back of wall = .926 ft. per foot

Distance down from base of rail to point where live load

$$\text{spread cuts the back of wall} = \frac{5.10}{.926} = 5.60 \text{ feet.}$$

Total spread of live load in fill = 6.5 + 4.0 + 2.80 = 1330 ft.

Unit vertical live load pressure per square foot of horizontal projection of back of wall $= \frac{12{,}000}{13.30} = 900$ lbs.

Unit horizontal live load thrust per square foot of vertical projection of back of wall $= \frac{900}{3} = 300$ lbs.

Summation of weights and their moments about toe of neatwork.

	Weight in Lbs.	Moment in Ft. Lbs.
A (1.0) (17.0) (100) (5.)	1,700	850
B (7.25) (17.0) (½) (150) (3.42)	9,250	31,600
Earth (7.25) (17.0) (½) (100) (5.883)	6,160	35,900
Live load (900) (4.85) (5.82)	4,370	25,500
Total	21,480	93,850

Summation of horizontal thrusts and their moments about top of footing.

	Thrust in Lbs.	Moment in Ft. Lbs.
Live load (300) (11.4) $\left(\frac{11.4}{2}\right)$	3,420	19,500
Dead Load (17.0) (17.0) $\left(\frac{100}{5}\right)$ $\left(\frac{17.0}{3}\right)$	4,8800	27,300
Total	8,220	46,800

Factor of safety against overturning $= \frac{93{,}850}{46{,}800} = 2.01$

The design of the neatwork is satisfactory.

DESIGN OF FOOTINGS.

Summation of weights and their amount about toe of footing.

	Weight in Lbs.	Moment in Ft. Lbs.
Neatword about own toe	21,500	93,850
Mass of neatwork times distances between toes = (21,500) (2.67) =		57,400
Live and dead load on heel = 900 + 17 (100) 11.42 =	2,600	29,700
Footing $(11.92)\ (2.5)\ (150)\ \dfrac{11.92}{2} =$	4,500	26,8800
Total	28,600	207,700

Distance from toe of footings to center of gravity of all weights $= \dfrac{207{,}700}{28{,}600} = 7.25$ feet

Summation of horizontal thrusts about bottom of footing

	Thrust in Lbs.	Moment in Ft. Lbs.
Live load $(300)\ (13.9)\ (13.9)\ (\tfrac{1}{2})$	4,150	29,000
Dead load $(19.5)\ (19.5)\ \left(\dfrac{100}{6}\right)\ \left(\dfrac{19.5}{3}\right)$	6,350	41,200
Total	10,500	70,200

Distance from bottom of footings to center of gravity of horizontal forces $= \dfrac{70{,}200}{10{,}500} = 6.7$ feet.

Distance from toe of footing to point where resultant of all forces cuts the bottom of footing $= \dfrac{207{,}700-70{,}200}{288{,}600} = 4.8$ ft.

Eccentricity about center of footings

$$= \frac{11.92}{2} - 4.8 = 1.16 \text{ ft.}$$

Average bearing $\frac{28{,}600}{11.92} = 2{,}400$ lbs. /sq. ft.

Maximum toe pressure $= (2{,}400) \left(1 + \frac{(6)\ (1.16)}{11.92}\right) = 3{,}800$ /sq. ft.

As this falls within the allowable bearing, the section as designed is satisfactory.

Bars in toe.

Maximum bearing	= 3800 lbs.
Average	= 2400 lbs.
Difference	= 1400 lbs.

Bearing at neatline =

$$\frac{(2.67)}{(5.96)}(1400) + 2400 = 3025 \text{ lbs.}$$

Average net bearing over to $= \frac{(3800 + 3025)}{2} = 3400$ lbs.

Moment $= (3400)\ (2.67)\ \left(\frac{2.67}{2}\right) = 12{,}100$ ft. lbs.

Steel required $= \frac{12{,}100}{(.87)\ (2.25)\ (13{,}500)} = .46$ sq. in.

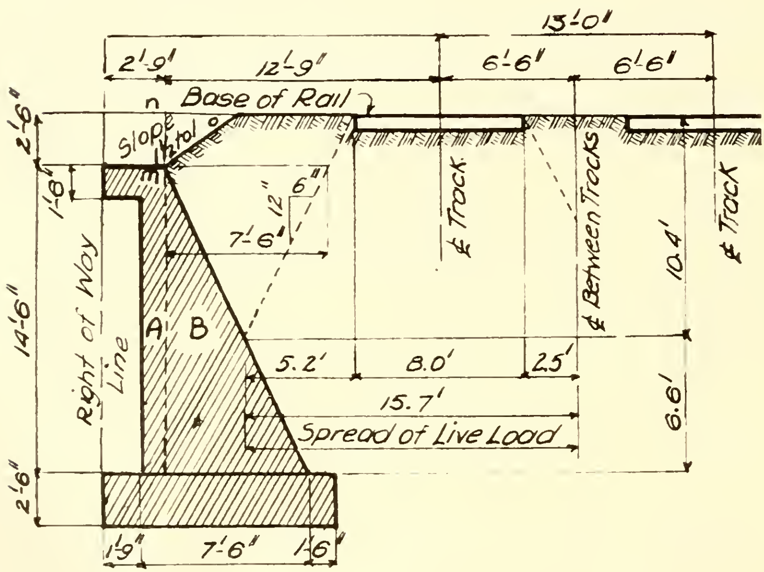
Use $\frac{3}{4}$ inch bars, 12 inch centers for good design. $A_2 = .56$ sq. in.

$$\text{Shear at neatline} = \frac{(3400)\ (2.67)}{12{,}127} = 28 \text{ lbs. /sq. in.}$$

$$\text{Factor of safety against sliding} = \frac{(28{,}600)\ (.5)}{10{,}500} = 1.4, \text{ which}$$

was assumed as being satisfactory, since the sheeting surrounding the footing excavation was left in place.

This design is therefore safe.



Assume:

Live load as 12,000 pounds per foot of track, distributed over eight feet of tie, and spreading 6 inches for each foot of fill descended.

Concrete as weighing 150 pounds per cubic foot, and earth as 100 pounds per cubic foot.

The horizontal thrust due to earth pressure at any point is equal to the head of earth above the point multiplied by one-

third the weight of a cubic foot of earth. The thrust due to live load as equal to one-third of the vertical live load.

Batter on back of wall $= \dfrac{6.5}{14.5} =$ .45 ft. per foot

Spread of live load .50 ft. per foot

Total convergence of live load spread and back of wall .95 ft. per foot

Distance down from base of rail to point where live load spread cuts the back of wall $= \dfrac{7.5}{.95} + 2.5 = 10.4$ ft.

Total spread of live load $= 6.5 + 4.0 + 5.2 = 15.70$ feet.

Unit vertical live load per square foot of horizontal projection of back of wall $= \dfrac{12{,}000}{15.70} = 765$ lbs.

Unit horizontal thrust per square foot of vertical projection of back of fall $= \dfrac{765}{3} = 225$ lbs.

Summation of weight and their moment about toe of neat-work.

	Vertical Load in Lbs.	Moment in Ft. Lbs.
A (1.0) (14.5) (150) (.5)	2180	1090
B (6.5) $\left(\dfrac{14.5}{2}\right)$ (150) (3.17)	7070	22400
*Earth (6.5) $\left(\dfrac{17}{2}\right)$ (100) (5.33)	5530	29500
Live load (765) (2.96) (6.02)	2270	13650
Total with live load acting	17050	66640
Total with no live load acting	14780	52990

---

* NOTE: In cases where surcharge is considerable, the weight and moment of the triangle of earth "mno" is subtracted.

Summation of horizontal thrusts and their moments about top of footing.

Live load $(255)\ (6.6)\ \left(\frac{6.6}{2}\right)$	5000
Dead load $\frac{(250+1700)}{(2)\ (3)}\ (14.5)\ (5.45)$	25700
Total	31300

Factor of safety against overturning

Live load acting $\frac{66640}{31300} = 2.13$

No live load acting $\frac{52990}{25700} = 2.05$

The neatwork is therefore safe against overturning. The investigation of footings is not repeated, as the method of obtaining the maximum toe pressures and the design is similar to that described under standard mass walls, except that two conditions of loading must be considered, namely, live load, acting and not acting. This is due to the fact that the track is located so far from the wall that the live load spread intersects the back of wall a considerable distance below base of rail, and has accordingly a much lower overturning moment, althought it still causes a considerable resisting moment.

The most unusual feature of the design of this particular wall is the extended coping which was built as shown, in order to hold the right of way line and permit of sufficient toe projection of the footing, to keep the bearing on the soil within the recommended value.

FULL SURCHARGED SECTION.

No live load was assumed as the wall is situated beyond the live load spread.

Assume:

Concrete as weighing 150 lbs. per cubic foot.

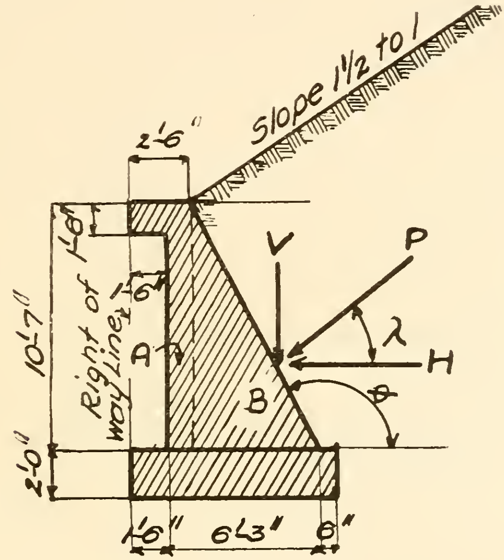
Earth as weighing 100 lbs. per cubic foot.

Angle of repose and angle of surcharge as 33° 42′.

Method of design as given on page 35 of Ketchum's Walls, Bins and Grain Elevators, 1911 Edition.

$$P = \frac{1}{2} w\ h^2 K$$

$$H = P \cos \lambda$$



$V = P \sin \lambda$

P = Total resulting pressure.

K = Constant depending on the angle of surcharge, values of which are given in curve on page 35 of the above mentioned book.

w = weight of cubic foot of earth, assumed as 100 lbs.

λ = The angle that the resultant of the earth thrust makes with the horizontal.

DESIGN OF NEATWORK.

Angle that resultant makes with the horizontal

$$\text{Angle } \Phi = \text{Tan}^{-1} \frac{10.58}{5.25} = \qquad = 116^\circ\ 30'$$

Value of K from curve = $= 1.9$

Angle that resultant makes with the horizontal $= 49^\circ\ 30'$

$$P = (190)\left(\frac{1}{2}\right)(100)(10.56)(10.56) = 10\ 600$$

Horizontal component = 10 600 cos λ = (10600) (.649) $= 6\ 900$

Vertical component = 10 600 sin λ = (10600) (.760) $= 8\ 000$

Summation of weights and their moment about toe of neatwork.

	Weight in Lbs.	Moment in Ft. Lbs.
A (1.0) (10.58) (150) (.5)	1 600	800
B $(5.25)\left(\frac{10.58}{2}\right)(150)(2.75)$	4 200	11 500
Earth (8 000) (4.5)	8 000	36 000
Total	13 800	48 300

Moment of horizontal thrusts about top of footing

$$= \frac{(6\ 900)\ (10.58)}{3} = 24\ 200 \text{ Lbs. ft.}$$

$$\text{Factor of safety against overturning} = \frac{48\ 300}{24\ 200} = 2.0$$

L

The design of neatwork is therefore satisfactory.

DESIGN OF FOOTING.

In the investigation of the footings the batter of the back is assumed to be the same as for neatwork, giving the same values of k and λ. The height, however, is assumed to the bottom of the footings.

$$P = (1.90)\left(\frac{1}{2}\right)(12.58)(12.58) = 15\ 000 \text{ lbs.}$$

Horizontal component = (15 000) (cs λ) = 15 000) (.649) = 9 800#

Vertical component = (15 000) (sin λ) = (15 000) (.760) = 11 400#

Summation of vetrical weights and moments.

	Weight in Ft. Lbs.	Moment in Lbs.
A (1.0) (10.58) (150) (2.0) =	1 600	3 200
B $(5.25)\left(\frac{10.58}{2}\right)(150)(4.25)$	4 200	17 900
Footing (8.25) (2) (150) (4.12) =	2 480	10 200
Earth (11 400) (6.66) =	11 400	76 000
Total	19 680	107 300

Moment of horizontal thrust about top of footing

$$(9\ 800)\left(\frac{12.58}{3}\right) \qquad 41\ 000$$

Distance from toe to point where resultant of all forces

$$\text{cuts the bottom of footing} = \frac{107\ 300 - 41\ 000}{19\ 680}\ 3.37 \text{ feet}$$

Eccentricity = 4.12 — 3.37 = 0.75.

$$\text{Maximum toe pressure} = \frac{19600}{8.25}\left(1 + \frac{(6)\ (0.75)}{8.25}\right) = 3700 \text{ lbs.}$$

This method of analysis was followed in the investigation of all the full surcharged walls on this project and was also used in computing the values used in plotting the curves included, in this article.

An inspection of the analysis of these various types of walls will show that the system of investigation is applicable also to the mass wall having a vertical rear face and also to the reinforced type of retaining wall.

These retaining walls so designed have held well to line, and as the cost of their construction is as low if not lower than cost of similar work for other railroad companies, the assumptions as made seem justified.

PART 3—THE MANUFACTURE OF SULPHITE CELLULOSE BY THE RITTER KELLNER PROCESS.

BY C. C. HERITAGE.

In the concluding part of this article we shall consider as concisely as possible the three remaining stages is cellulose manufacture by this process.

The first of these three is the preparation of the raw cooking acid which consists chemically of a solution of the bisulphites of calcium and magnesium in sulphurous acid. To prepare this solution, two types of acid plants are in use and find nearly equal favor. These are known as the tower system, and the tank or milk of lime system, respectively.

In both systems, sulphur dioxide is prepared by the combustion of elementary sulphur or the roasting of pyrites, depending on local conditions. The former is much to be preferred from a mechanical standpoint, and we shall confine our attention to the combustion of sulphur. This material, as produced in our southern states is practically pure, the impurities and moisture seldom exceeding .5 % and never reaching 1%. The most common burner is shown in Plate IX, and consists of a steel plate cylinder fifteen feet long by five feet in diameter carried on steel rings, as shown, and reduced at each end to an opening about one and one-half foot in diameter. The forward end serves to introduce the sulphur, while the rear opening leads to a combustion chamber. The sulphur may be introduced either in the solid or liquid phase and lies as a molten burning mass four to six inches deep in the bottom of the burner. As the shell rotates slowly a thin layer of burning sulphur adheres and vaporizes during the rotation. The burner, as it is commonly termed, is essentially a vaporizer, the combustion proper taking place after the gas has left the burner, this is allowed to enter at each end, that entering in front being termed primary and that in the rear, secondary. The former governs the quantity vaporized in a given time while the latter regulates the percentage SO^2 in the resulting gas. Theoretically with ideal conditions of combustion, a gas of 21 % SO_2 should be obtainable but practically a higher gas than 18% is undesirable because of the danger of sulphur sublimation in the coolers.

Another type of burner which has recently found considerable favor is shown in Plate X. It has no moving parts and occupies a very small floor space. The sulphur in liquid form flows downward from plate to plate, being completely vaporized as the bottom plate is reached, and the gases of combustion pass upward counter current to the flow of sulphur, and are drawn off from the top shelf.

The gas after leaving the combustion chamber is at a temperature of about 900°C and is cooled indirectly both by air and water. All piping from the water cooler through the system to the digesters must be of hard lead.

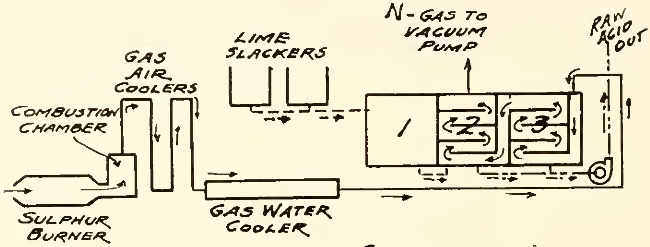
Plate IX.

In the tower system, these gases are passed up through limestone loosely packed in the towers whose height varies from 50 to 100 feet. Water is introduced at the top and in trickling downward absorbs the gas forming sulphurous acid. This in turn reacts with the stone producing first the monosulphites of calcium and magnesium and then the bisulphites of the same bases, which salts are soluble.

The same end is attained in the milk of lime system by slacking burned lime with steam and water and diluting the milk thus produced to a strength of 1.1° to 1.6° Baume, depending upon the strength of acid it is desired to make and the quality of the lime used. The gas is then sucked through this dilute milk of lime

which gradually clears to a colorless solution of the bisulphites in from thirty to sixxty minutes. These reaction tanks noted in Figure 3 as the monosulphite and make up tanks are handled so that while the latter is being emptied, the former, being as yet unsaturated with sulphur dioxide, takes up this constituent until the contents of this tank may be transferred to the make up tank and the monosulphite compartment again filled with fresh milk of lime. In this way, although the production of acid is intermittent, the flow of gas is continuous. This flow is maintained throughout the system by means of high capacity vacuum pumps and it is thus evident that the entire system back to the burners

DIAGRAM OF ACID PLANT.
STEBBINS MILK OF LIME SYSTEM.



→ FLOW OF GAS
-→ FLOW OF MILK OF LIME
--→ FLOW OF RAW ACID
1 - LIME WATER TANK
2 - MONOSULPHITE TANK
3 - MAKE UP TANK
FIG 3

C.C.H
11/2/15

is under a vacuum whose value is atmospheric at the burner inlet and increases to about 12 inches at the pumps. It is necessary to agitate the solutions throughout the system since calcium monosulphite is insoluble and it is not until the makeup tank is reached that a clear solution of bisulphites result.

The production of acid is always under strict chemical supervision, although in many mills, the acidmakers themselves perform the iodine and caustic titrations. These standard solutions are made up exactly 1/16 normal so that on a 2 c. c. sample of acid, the barette reading when pointed off one place to the left gives the percentage SO_2 directly assuming the specific gravity

of the acid to be one, which is of course not strictly true. The results, however, are very satisfactory for technical control. The iodine titration gives the total SO_2 present both as bisulphite and free sulphurous acid. The caustic titration, with phenolphthalein as indicator, performed upon a separate sample gives the sum of SO_2 present as sulphurous acid and one-half that present is bisulphite and is called "free." The difference between the two titrations is called the "combined," and of course represents amount of SO_2 which would be in combination with the bases were only monosulphite present. Therefore in speaking of the strength of acid, the three values, namely, Total, Free and Combined are always given. The raw acid from a system such as described runs 3.40% Total, 1.90% Free, and 1.50% Combined.

Many other points of interest might be discussed in this connection if space permitted. The above is only the briefest kind of a review of the essential features. We shall next consider the second stage, the digestion of the chips, by far the most important unit in cellulose manufacture.

The cooking is carried out in a bank of digesters, numbering from two to twenty or more in the larger installations. These may vary in capacity from four to sixteen tons each or even larger, rated in terms of the weight of pulp produced per cook. The tendency is toward the use of larger units. An eight ton digester, which is a common size, is sixteen feet in diameter by forty-two feet in height, making a content of 4,400 cu. ft. The shell is built up of special steel plate, and is lined with two courses of brick, the inner one of which is acid proof, and pointed up with a mixture of litharge, cement and glycerine. This gives a wall practically impervious to cooking acid at any reasonable temperature. Grouting is poured in between the shell and the first course of brick. Frequent inspection of the digester is necessary, however, and any leaks are stopped and faulty or disintegrated brick replaced.

There are no two sulphite cooks, to say nothing of any two separate mills, who cook in exactly the same manner; and it is remarkable that, with the great variations which obtain throughout the industry, the resulting pulp should be as uniform in quality as it is. It would be impossible to consider in any detail the various methods of cooking in vogue in the production of Rittter

Kellner cellulose in this article, and therefore we shall describe briefly the cycle of one of the commonest and simplest procedures.

The chips prepared as described in Part II of this article are run by gravity from the overhead storage bins into the top of the digester. Referring to Plate XI, the top of a digester appears at A with cover bolted in place after filling, and at C is shown the chip spout through which the chips are introduced.

The cooking liquor, which is very different from the raw acid whose manufacture has just been described as will appear shortly, is pumped from the reclaimed gas tank into the digester up to

Plate XI.

within five feet of the digester top. See Fig. 4 in this discussion. Live steam is now turned in at the bottom through the lines marked C in Plate XII. The jets impinge on each other immediately after leaving the lines, in such a manner that a violent upward vortex is formed, thus setting up a good circulation of liquor among the chips which is very essential to the production of uniform pulp. The digester is brought up to the desired pressure as rapidly as possible, generally in about two hours on an eight hour cooking schedule. Just before the desired pressure is reached, the entrained air is allowed to escape from the top of the digester through the relief gas line and liquor takes its place. As a general rule in the more progressive mills two relief lines

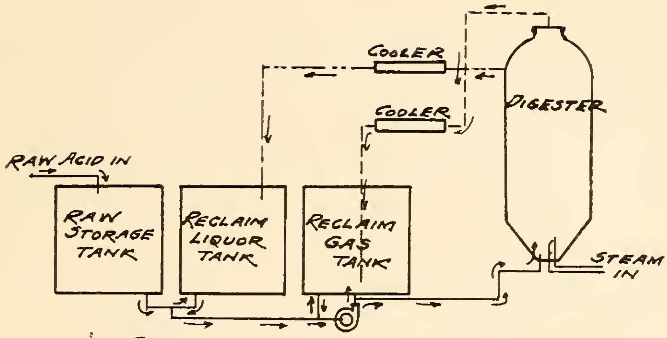


DIAGRAM SHOWING MOVEMENT
OF
VARIOUS FLUIDS
IN
RITTER-KELLNER COOK
FIG 4

C.C.H
11/2/15

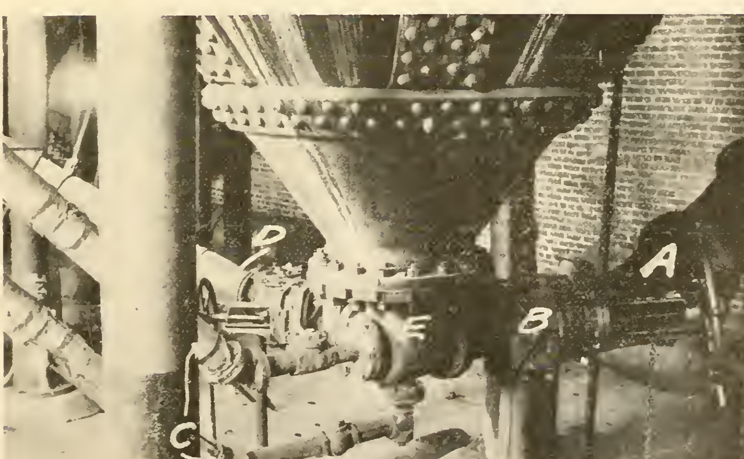


Plate XII.

are used during the cook, one leaving from the top cover shown in Plate XI at B, called the relief gas line, and one leaving about ten feet down from the top on the side called the relief liquor line, the controlling valve of which appears also in Plate XI at D.

The working pressure at which the digester is held during a cook depends upon the time within which it is desired to complete the operation. Likewise the final temperature obtained depends on this selected pressure. Thus there are three fundamental variables, all interdependent, the higher pressure and temperature corresponding to the shorter time. In the particular procedure under discussion, the pressure is held at 75 lbs. and the temperature at the end of two hours is about 110°C.

The pressure existing is the sum of two pressures, that of the steam admitted and that of the SO_2 gas which is set free from the cooking liquor by reason of the increased temperature since both the bisulphites and the sulphurous acid become unstable as the temperature rises. At 110° it is evident that practically all the pressure is due to gas. In order to increase the temperature but held the pressure constant it is now necessary to relieve liquor which has increased in volume due to the condensed steam. This relief liquor as shown in Figure 4 passes through a cooler and is mixed with the raw acid from the acid plant in the reclaimed liquor tank. Since this liquor has already been diluted, it is weaker than the raw acid and therefore dilutes it somewhat.

The relief of liquor continues for three to four hours, or until the temperature has risen to about 1745°C. So much gas has been set free by this time that it becomes necessary to relieve gas from the top, which gas is a mixture of steam and SO_2 averaging about 80% of the latter. This gas is cooled similarly to the relief liquor, but is delivered into the reclaimed gas tank into which a charge of raw acid and reclaimed liquor has been pumped immediately after the digester was filled. This very strong gas "blows up" the liquor, thoroughly saturating it with SO_2, thus bringing up the "free" to about 3.50% and reducing the percentage "combined" to 1.00, making a "total" of 4.50%. This liquor is then used in the next digester to go on cook.

The liquor assumes a dark red color as the relief of gas is continued in greater quantity up to the end of the cook. The liquor also takes on a peculiar pleasant odor and by these two physical

properties, the experienced cook judges the progress of the reactions. When the liquor shows less than .1% total SO_2 the blow off valve appearing in Plate XII at B is opened and the contents of the digester is blown by its own pressure through the blow pipe A to the blow pit, an oval tank built up of 5-inch staves which is provided with a large outlet for steam and vapors called the vomit stack, and a perforated bottom covered with heavy cocoa matting through which the waste liquor drains away. In

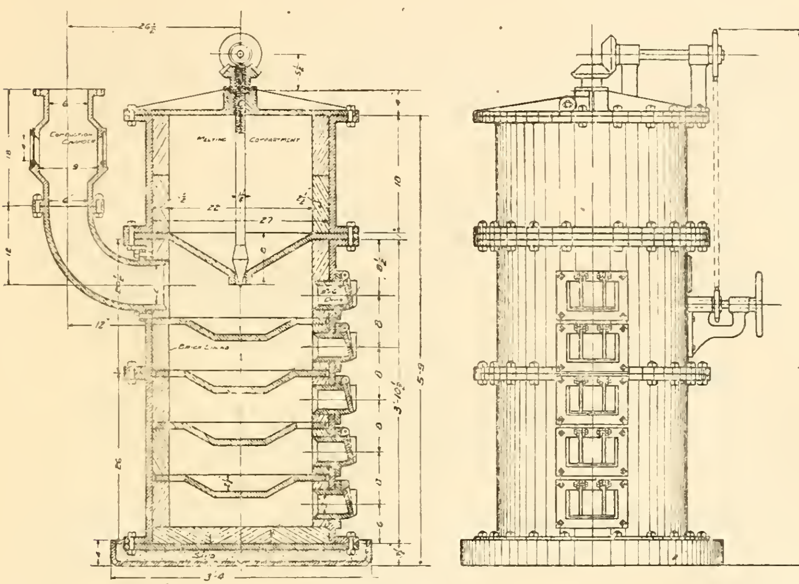


Plate X.

Plate XII, D is the acid inlet to the bottom fitting E of the digester.

The two charts reproduced herewith show the values for pressure and temperature throughout three complete cooks.

The reactions occurring in the digester are exceedingly complex. The sulphur appears in the waste liquor as calcium and magnesium liquo-sulphonates. Good practice shows a sulphur consumption of 240 lbs. per ton of pulp produced, and a lime consumption of 195 lbs. No process at present exists for the recovery of these substances, although the lignin and sugar recovery for fuel and alcohol respectively have been commercially ex-

ploited by Strelevert and Ekstom, both abroad and in this country.

The remaining units in the process are relatively unimportant from a chemical engineering standpoint and will be reviewed briefly. Figure 5 shows the movement of "stock," as the suspension of cellulose fiber in water is termed in the mill.

The stock is thoroughly washed in the blowpits and flows by gravity to a large storage tank. From here it is pumped through various screening devices to remove first the large knots and uncooked chips, and later the larger fiber bundles, called "shives," not thoroughly disintegrated in the cook. On the flat screens the fibers are sucked through very narrow slits about .010 inches in

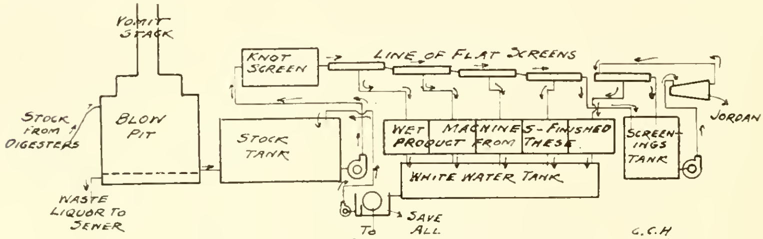


DIAGRAM OF MOVEMENT OF STOCK THROUGH WET ROOM.
FIG. 5

width and pass by gravity to the dewatering equipment known as wet machines. Here the stock enters a vat on the outside of a revolving cylinder, almost submerged in the stock and covered with 64 mech brass wire. The water passes through the wire, depositing the fiber on the wire in a thin sheet. This sheet is carried up until it comes in contact with a coarse nap felt running tangent to the cylinder, to which the sheet clings in preference to the wire, is further conveyed over a suction box and through press rolls to remove all the water possible, and is delivered from the machine in laps containing about 40% air dry pulp. By the term air dry, a moisture contact of 10% is assumed. Plate XIII is a view of the warehouse showing the appearance of the laps ready for shipment.

Every precaution is taken to recover all good fiber. The white water from the wet machine cylinders is passed through a save-

all so that any fiber passing the cylinder is caught here and returned to the stock tank. The screenings are collected and ground fine enough in a Jordan to pass the flat screens and ultimately find their way into the finished product. The only possible escape for fiber is through the blowpit bottoms, where the liquor is of such a corrosive nature that the upkeep on a save all for this purpose would exceed the profit accruing from its use.

Be liberal in the measure of your work. Don't even think of excusing yourself from doing what you reasonably can, by saying that you are doing as much as you are paid for. As long as you hold the position, and accept the pay, do good, honest, faithful work. If the labor demanded is too great, make a courteous, frank, straightforward protest, or offer your resignation.

—Baker.

The genuine engineer, like the genuine man in any walk of life, will be preparing all his life. Each achievement he will value not merely for the wealth or glory it brings him, but as a preparation for something beyond. He who has got through all preparation work is dead.

—Smith.

In all your work cultivate to the utmost the attributes of reliability and accuracy and never let any computations be used unchecked, the checking being done either by an independent computor or by an entirely different method of figuring. I cannot impress upon you too earnestly the importance of a thorough check on all work. Without it, mistakes, and sometimes serious ones, are sure to occur, for the man who makes no mistakes is the man who does no work.

—Waddell.

PART 3—WATER POWERS OF SOUTHEASTERN ALASKA.

BY LEONARD LUNDGREN

District Engineer, U. S. Forest Service, Portland, Oregon.

SITKA REGION.

GENERAL

The Sitka Region is bounded on the east by Chatham Strait, on the south and west by the Pacific Ocean, and on the north by Cross Sound and Icy Strait, and contains Chichagof, Baranof and adjacent islands. The land area of this district is 4500 square miles, the greater portion of which is included in Chichagof and Baranof Islands.

These two islands form, in effect, a single land mass, gradually tapering southeastward, separated into two parts only by a narrow body of water known as Peril Strait. The extreme length from Point Adolphus on the north to Cape Ommaney on the south is 150 miles, and the average width is thirty miles. Tenakee Inlet and Whale Bay penetrate into the heart of the islands and render territory accessible that is otherwise nearly impenetrable. The relief is rugged, and the mountains rise abruptly from the shore to heights of two and three thousand feet. Little is known concerning the interior.

Sitka was for many years the capital and largest city of Alaska. During the development of the Juneau gold mines Sitka's importance decreased, and it is now of interest only for its historic relics and missionary schools. It has now only a few hundred inhabitants.

Developed Water Powers.

The *Sitka Wharf and Power Company* is the public utility of Sitka. This company has constructed a plant on Silver Bay, five miles easterly from the town. A wood stave pipe 42″ in diameter develops a head of 60 feet. The rated capacity of the water wheel is 350 hp. and the capacity of the generator is 200 kw.

The *Sheldon-Jackson School* is a denominational institution for educating half-breed Indian children. The good work that is being accomplished here can only be appreciated by a visit. Two pipe lines 24 and 26 inches in diameter develop a head of 24

feet. The water wheels have a total capacity of 80 horse power and supply light and power to the school.

The *Chichagoff Mining Company* owns and operates the Chichagoff and Golden Gate Mines, located at the head of Klag Bay, an arm of the Pacific Ocean, about fifty miles northwest of Sitka. Its water power plant is located four miles southeast of their mill on Simmons Creek and furnishes the power necessary for their operations. A small crib dam was constructed across the outlet of Rust Lake two miles from tidewater, and a tunnel 180 feet long was driven thru the natural rock dam at the outlet of the lake. The intake is twenty feet below the crest of the dam. The total storage of 3800 acre feet is secured in this manner. The diversion dam is about one and one-half miles below the outlet of Rust Lake and is formed by drift-bolting a log to bed rock with a plank facing. The water flows directly into a flume 352 feet long and three feet in width and then into a riveted steel pipe having an average diameter of 24 inches and a length of 1800 feet. The power house is a rough frame building, in which are installed one Pelton-Doble water wheel of the capacity of 500 hp., direct connected to a 300 kva. generator. A transmission line four and one-half miles in length transmits the current to the mill of the company.

The first water power plant of the company was constructed in 1909. A small log dam diverted the water into a conduit 350 feet in length, giving a head of 110 feet on the water wheel. A 250 hp. turbine was installed, direct connected to one 127.5 kw. generator. This plant is now held in reserve. It was replaced because the company found that additional power was required.

The *Olson Saw Mill* is situated at the head of Warm Springs Bay, a branch of Chatham Strait, at Baranof, Baranof Island. It is located twenty miles easterly from Sitka and about one hundred miles by steamer. This mill is operated only during the summer season and is a crude affair. A small flume about 300 feet in length conducts the water to a 14″ wood stovepipe 300 feet long. A head of 75 feet is assured on a 40″ Pelton wheel, which operates a circular saw. About 25 hp. is developed. This plant would not interfere with the Warm Springs project, discussed below, as it is operated only during the flood season and the amount of water diverted is insignificant.

The *Hoonah Lumber Company* owns a small saw mill which is located about a half mile northwest of the Hoonah post-office on the shore of Port Frederick, Chichagof Island, seventy miles north of Sitka and forty miles southwest of Juneau. A flume 300 feet in length, 14 inches wide and 12 inches deep conducts water from a small mountain stream to the saw mill, where two water wheels having a total capacity of 15 hp. operate the machinery.

The *Hoonah Packing Company* operates a cannery at Hoonah, and has built a small conduit for supplying water for washing purposes and operating a 10 hp. water wheel.

UNDEVELOPED WATER POWERS.

The *George E. James Company* plans to construct a small power plant to operate a proposed saw mill at the head of Sulcia Bay, a branch of Peril Strait, located about twenty-five miles northwest of Sitka. The water of Weigle Creek will be diverted about one mile from tidewater into a flume which follows the contour to a point on the hillside above the mill, securing an effective head of 170 feet. A penstock about 600 feet in length will then take the water directly to the turbines. The power that may be secured under minimum stream flow conditions is about 300 hp. This can be increased by constructing a dam across the outlet of Weigle Lake, which is located a short distance above the point of diversion.

Warm Springs Project is located at Baranof, at the head of Warm Springs Bay, a branch of Chatham Strait. It is located on the opposite side of Baranof Island from Sitka, twenty miles easterly in a straight line and about one hundred miles by steamer. The anchorage is excellent and a wharf for ocean steamers can be cheaply constructed. Baranof Lake, having an area of 700 acres, is located less than a quarter of a mile from tidewater, with a surface elevation of 130 feet above high tide. It has been estimated that the minimum capacity of this site is 6000 hp. The government is now engaged in securing stream flow data, so that more accurate estimates can be made.

Green Lake Project is located at the head of Silver Bay, a few miles southeasterly from Sitka. The outlet of the lake is in a narrow canyon, where a dam 150 feet high can be constructed with a crest length of only 300 feet. The dam would be constructed about 1800 feet from the bay, in which distances the

stream falls 240 feet. It is roughly estimated that this site has a power capacity during the normal year of approximately 6300 continuous horsepower. Stream flow measurements are now being carried on by the Government in order that better estimates may be made.

THE JUNEAU REGION.

GENERAL.

The Juneau Region comprises that portion of southeastern Alaska consisting of Admiralty and Douglas Islands and the mainland lying to the eastward from Berner's Bay to Port Houghton. It is bounded on the north and east by British Columbia, on the south by Frederick Sound and on the west by Cratham Strait and Lynn Canal. The total land area is 6800 square miles.

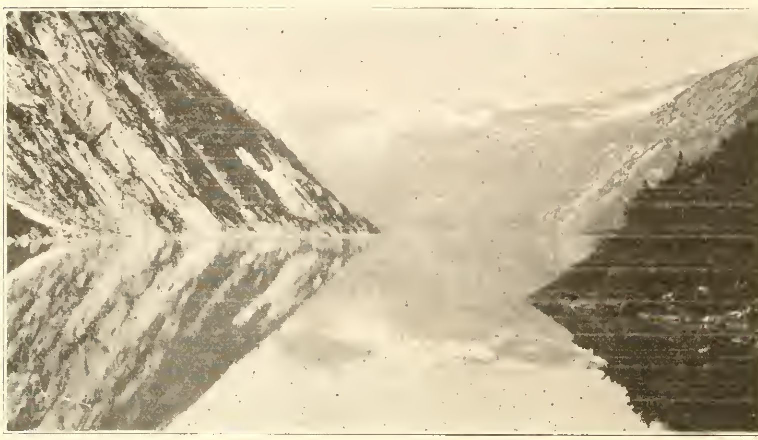
This section has the mountainous character of the entire coastal region of British Columbia and southeastern Alaska. The higher mountains reach to elevations of five to seven thousand feet, while occasional mountains rise a thousand feet higher. Almost invariably the mountains rise abruptly from the water's edge, and heights of 2500 to 3500 feet are common within a mile or so of salt water.

The region between Tracey Arm and Taku Inlet is dissected by close-spaced valleys, yet beginning about six miles from Stevens Passage, the average elevation of the summits is more than 4500 feet. Beyond Taku Inlet as far as Berner's Bay, elevations near the shore range from 2500 to 3500 feet. The latter figure is approached on Douglas Island and is exceeded within a mile of Castineau Channel, near Juneau. In this district the majority of the summits rise above 5000 feet within ten miles of the coastwise channels. Opposite Lynn Canal the mountains rise to heights of 6000 feet. Numerous lakes and basins which may be used to store water are located in this region. The Taku River is the largest in this region and, next to the Stikine, is the largest river in southeastern Alaska. Neither has any power value in American territory. The next rivers in size in the Juneau district are the Speel and Whiting.

Juneau is the principal port of the district and is the capital and largest city of Alaska. Its importance is due to its strategic

location near the Juneau gold belt. Juneau is situated on Gastineau Channel, and in a commercial sense includes the towns of Douglas, Treadwell and Thane, the three are separated communities. Because of shoals caused by debris from Mendenhall Glacier and Lemon Creek, at the northern end of Gastineau Channel, steamers are compelled to make a detour around the southern end of Douglas Island, which adds two hours to each trip of the steamers that call at this port.

The Juneau Gold Belt comprises the mainland strip from Windham Bay northward to the head of Lynn Canal, together with Douglas Island. The gold placers of this area have been

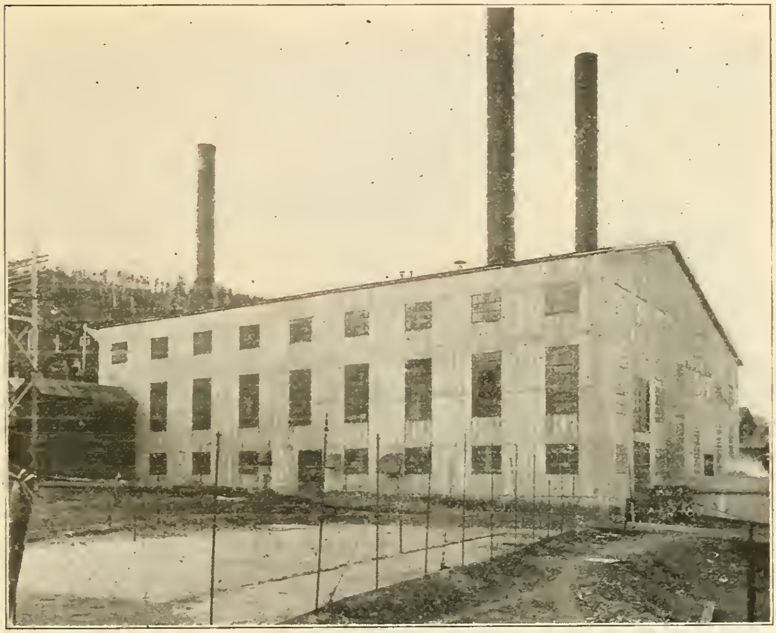


Lorig Lake, Speel River Project.

located and worked out, together with the richer surface ore. Great bodies of low-grade ore exist throughout the "Gold Belt," and the future looks very promising for mining this ore on a large scale.

The history of this locality reads like a novel. In the spring of 1880 N. A. Fuller, of Sitka, on the strength of a favorable report by John Muir, sent Joe Juneau and Richard Harris to investigate the coastal belt between Windham Bay and Sullivan Island. These two prospectors, with three Indians as guides and packers, arrived at Windham in May. Several quartz veins were located and recorded. As they were not encouraged by their discoveries here they continued prospecting along the coast to

Gold Creek, where they arrived the middle of August. Rich gravels and specimens of quartz float containing free gold were found. Following up the stream and crossing the ridge at the head of Snowslide Gulch to Silver Bow basin, they discovered gold quartz in place. From these ledges, at present the property of the Alaska Juneau Company, they carried off nearly 1,000 pounds of ore to Sitka early in November, after staking out placer and quartz claims. This strike caused great excitement, and November 26th a party of thirty started for Gold Creek,



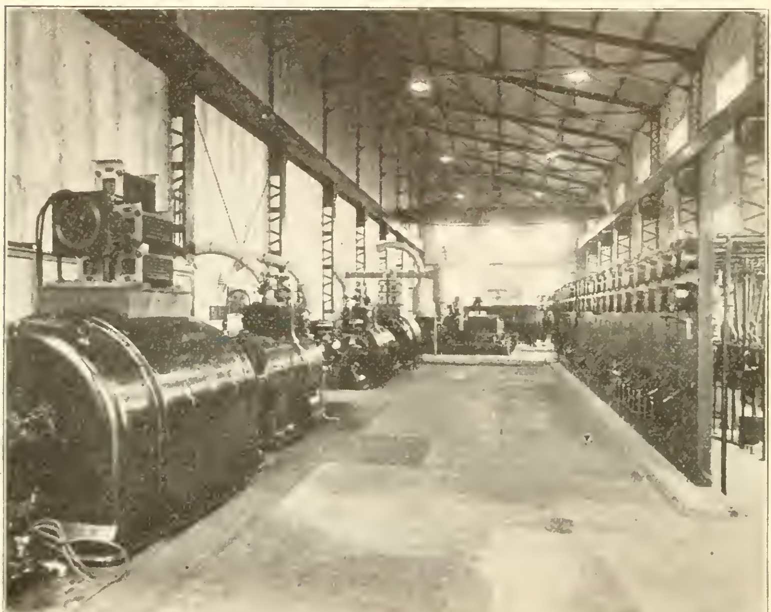
Central Steam Power Plant Works of the Treadwell Mining Co., near Juneau.

where they arrived December 6th. Numerous locations were made that winter and the hills were deeply covered with snow, the small colony continued to grow and founded the present town of Juneau.

The activity continued through the next year and the entire region was prospected. Among the numerous locations made were the Treadwell mines and most of the mines now under development. In the autumn of 1881 the population of the village numbered about 100. It was first called Rockwell and later Har-

risburg, but at a miners' meeting held December 14, 1881, it was voted to rename the town in honor of the elder of the two discoverers of the district. The record of this meeting shows that 72 men were present. Later the "Harris Mining District" was so named after Juneau's partner, Richard Harris, at that time recorder of the district.

In 1882 Juneau was the mining center of Alaska. On Douglas Island the Treadwell claim, owned by San Francisco capitalists, was the only one thoroughly developed. Four tunnels had



Interior View of Central Steam Power Plant, showing 2-10000 K. W. Parsons Turbo-Generator, 1-750 K. W. Curtis Turbo-Generator, together with switchboard.

been run into the ledge and a large body of low-grade ore exposed. A 5-stamp mill, erected in 1882, was in operation, and several bullion shipments were made during the year. This was the first quartz mining undertaken in the district except some small developments on the ledges of Quartz Creek in the Silver Bow district.

In regard to the discovery of the Paris lode and its original ownership, now the property of the Treadwell Mining Company, several different stories are current. The only early official record is the following: "September 13, 1881, transfer of Paris lode from Pierre Joseph Erussard (or 'French Pete'), original locator, to John Treadwell, in consideration of the sum of five dollars ($5.00)." No other conditions were stipulated. The development of hard-rock mining on the Treadwell property was greatly hindered by placer miners, who claimed the surface rights and by forcible means not only held the ground, but washed gold from the decomposed outcrops to the value of several thousand dollars.

During the succeeding years until 1885 most of the properties now regarded as of value were located, and from 1885 to 1895 the greater part of the ground was patented and various mining companies formed. As the ore from most of the quartz mines was low in value, it required careful and economic treatment not only to win the free gold but to save the sulphides and concentrates. Among the first mills constructed for this purpose were two on Douglas Island, the Nowell mill of 60 stamps and that of the Bear's Nest Company of 80 stamps, neither of which was ever operated.

On the Treadwell and adjacent properties, after sufficient ore had been developed to warrant expenditure, large stamp mills were constructed. The first of these, erected in 1887, at the Treadwell mine, contained 120 stamps, and the following year 120 stamps were added. Between 1893 and 1896 three mills—at the Mexican, Seven Hundred Foot, and Ready Bullion mines—and the 300-stamp mill at the Treadwell mine, were built. This plant has all been remodeled, and 900 stamps are now in operation equipped with the latest improvements.

The extensive low-grade gravel deposits of Silver Bow basin were opened in 1891 by the Silver Bow Basin Mining Company. The same year this property was transferred to the Nowell Gold Mining Company, and from 1891 to the end of 1902 it was worked continually during the placer-mining season. The production of this placer alone was estimated at $416,000 and, adding to this the output of smaller placers on Gold Creek, would give us a total yield over $500,000.

Encouraged by the success of the Alaska Treadwell Gold Mining Company, several other companies have been organized and are planning similar developments. The more important of these companies are the Alaska Gastineau Mining Company, the Alaska Juneau Mining Company, and the United States Smelting, Refining and Mining Company. The Alaska Gastineau Mining Company, after a number of years of development work, commenced active operation of its mines during the spring of 1915, and their mill of 8,000 tons capacity is now in full operation. The Alaska Juneau Mining Company is engaged in active development work, and operation is expected in the near future. The United States Smelting, Refining and Mining Company has taken over what is known locally as the Ebner properties and is engaged in preliminary development work. If these companies meet with the success experienced by the Alaska Treadwell Gold Mining Company other equally large developments may be expected in the Juneau region.

The watersheds adjacent to these mines have been carefully examined for their power value, and the largest hydro-electrical plants in Alaska have been constructed here to furnish power for the tremendous tonnage which must be mined for the successful operation of low-grade ore mines. All of the companies now in the field need more power, and considerable construction work in addition to that now under way is expected in the near future.

Developed Water Powers

The *Treadwell Group* of four mines on Douglas Island is operated under one management by three companions, as follows: The Alaska Treadwell Gold Mining Company operates the Treadwell mine; the Alaska Mexican Gold Mining Company operates the Mexican mine; and the Alaska United Gold Mining Company operates the Ready Bullion and 700 Foot mines. These companies have their main office in the Mills Building, San Francisco, California, and the office of the General Superintendent at Treadwell, Alaska. While the records of ore production and profits are kept separately, from an operating viewpoint, these four mines may be regarded as one, and are so considered herein. Mr. F. W. Bradley is president of all the companies named above and of the Alaska Juneau Gold Mining Company.

THE CYCLOIDAL WEIR METER

BY W. M. BREADY, JR.

Sales Engineer, Engineering Department of The Kennicott Company, Corn Exchange Bank Bldg., Chicago.

One of the most important measurements in a power plant is the measurement of the boiler feed water. In the average plant, measurements are made of the CO^2, coal, smoke, ash, etc., but the feed water is neglected. In the engine room hundreds of dollars are spent taking a crook out of an indicator card, while in a majority of cases neither coal nor feed water is measured.

Realizing that this item is of paramount importance to power plant engineering, the company decided to produce a meter and place it on the market; such a meter to be very accurate at all heads and capable of handling large volumes of water. During the past year, the experimental department tested all types of meters and various weirs, and after investigation it was decided to try to produce a weir that would give the quantity of water flowing through it, directly proportional to the head. This would eliminate the intricate integrating mechanism necessary to record the odd powers of the head of the ordinary rectangular or "V" notch weir, and at the same time produce a meter which would be accurate at low flow as well as high, as stated before. It is the item of low flow on a weir or Venturi meter which causes the greater inaccuracy, thus the desire to eliminate it.

After numerous experiments, the cycloidal weir was produced,, but not until its wonderful accuracy had been thoroughly demonstrated was it discovered that the shape of the weir was that of a right cycloid. Subsequently it was proven, that the theoretical curve was that of a right cycloid, and that the actual curve, obtained by experiment, in practice, and perfected by numerous tests, conforms closely to the right cycloid.

REASONS FOR ACCURACY.

There are several reasons why the cycloidal weir is more accurate than the other measuring devices of this type.

1st. The registering and recording mechanism is simplfiied and more accurate than the others. This is described later.

2nd. At low flow, when there is only a fraction of an inch head above the crest, the water *leaps* clean by falling vertical downward from the edge. It does not "trickle" or "drizzle" down the face, thus causing the inaccuracy, as is the case in other types of weirs.

3rd. Since the flow of water is in simple direct proportion to the head, the average head operated by the float, operating the registering mechanism, gives correct results. With the ordinary weirs the average head does not give correct results, because the amount of water flowing at times, when head is above average, far exceeds the amount flowing when head is below average.

ADVANTAGES.

A few advantages of this type of weir are given as follows:

1. The complicated recording mechanism, necessary to take care of the odd powers of the head, is entirely eliminated.

2. The construction is simple and working parts are reduced to a minimum.

3. The main weir is easily cleaned. The register and recorder are easily accessible.

4. It is accurate at all rates of flow within the capacity of the meter; at high head as well as low head.

5. It operates equally well with hot or cold water.

DESCRIPTION OF WEIR.

The weir itself is made of cast brass, its surface closely approximating a right cycloid. It is made hollow, the water flowing around it through slotted orifice, down through weir into storage compartment. The figures represent a good view of the weir itself.

According to capacity required, one, two, three, or four of these weirs are used, each having a capacity of 150,000 pounds per hour. Thus it is comparatively easy to supply the demands of the individual power plant.

The weir box, which is constructed of ¼′ to ⅜′ steel plate, is separated into two parts, namely—the weir chamber (above) and storage compartment (below) by the weirbed plate. Onto this bed plate is bolted the desired battery of weirs, as shown in side elevation.

The water enters the weir chamber through the balanced valve, which is governed by the height of water in storage cham-

ber. Upon entering, it encounters a circular baffle around the pipe, and upon flowing through the channel of approach it encounters straight perpendicular baffles, which serve to still the water before it reaches the weir.

Running from a point a little bit below the crest of the weir is a pipe, which leads to the float chamber, thus insuring an absolutely still water at exactly the same head as on the weir. This serves to actuate the float which governs the recording device.

RECORDING DEVICE.

The recording device of the weir consists of three distinct items, two of which are customary on the other weirs, and a third which is absolutely new. This machine is equipped with a continuous register, a graphical recorder, and an instantaneous indicator. This instantaneous indicator shows directly on the large dial just how much water is flowing through the weir at the particular moment you look at it, thus you know immediately what your weir is doing without figuring.

The graphical recorder makes a graphical chart of the readings you have on the dial of the indicator. It carries a tape capable of a two months' duration, but can be made daily or weekly, if desired.

The continuous register is a continuous counter, registering at all times the volume of water running through the weir. All instruments are built by the Bristol Instrument Company.

The float which operates the recording device is made of copper and properly counterbalanced to insure as nearly perfect operation as possible. As the head of water in the float chamber rises or falls the float is so actuated, thus moving the vertical shaft carrying the small friction gear and circular rack. shown in illustration of recorder.

The large friction plate is driven by double spring eight-day clock mechanism and is rotating at all times when the weir is in operation.

When water is at zero head, the friction plate and friction gear are in neutral position; that is, the small gear is in contact with the larger at the center and, therefore, no recording takes place. Also the pinion carrying the hand of the indicator is at its zero position. This pinion is in connection with the float

device by means of the circular rack (not a worm), the reason for this being that there is rotary motion as well as vertical.

Let a flow of water come on the weir, say half head; the float rises, carrying the friction gear up and moving the pointer of the indicator to its proper position, which can be done only because the flow is directly proportional to the head.

As the friction gear rises the gear ratio changes; thus the higher head the faster will the counter be driven to take care of this increased volume. The bevel gears on the vertical shaft are equipped with a feather key to permit free vertical motion of the shaft while the gears are in mesh.

If the volume of water be reduced to one-quarter full capacity, the instantaneous reading will be half of the previous, in a direct proportion, and the gear ratio of the friction gears will be reduced accordingly.

The graphical recorder is operated by means of "U" tube and float, similar to the operation of other graphical recorders.

While comparatively new on the market, it has taken the engineering field by storm. Great interest has been displayed in regard to it, especially because of the small percentage of error.

Engineering is a noble calling and the men who follow it need not necessarily, if they so mind, be swallowed up in a sea of materialism. Matter is universal and clothes the seat of thought and spirit. In molding matter to the uses of man the engineer but adapts himself to the conditions of a material world. The real engineer is the intellectual force and spirit back of matter. So far from being debased, he is to be congratulated that his mind may work in such close harmony with nature. His mental processes are sane and true, and drawing their inspiration from nature they find there an unlimited source. He need not be ashamed of his calling; let him see to it that he is worthy of it and that he uses the rich opportunity to grow into the full measure of manhood.

—*Constant.*

The Armour Engineer

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TERMS OF SUBSCRIPTION.

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The executive council of Armour Institute of Technology have appointed the following men as members of the staff of The Armour Engineer for the school year, 1916-1917:

Laurence A. King...............Editor-in-Chief
Abraham Corman..............Managing Editor
Leonard E. Starkle............Business Manager
Walter Wollaston....Associate Business Manager

Judging by the magnificent Cycle of this year we can only look for the splendid success of the Engineer next year under the able management of Mr. King, and we ask our readers to join us in a hearty welcome to the incoming staff.

THE ENGINEER IN THE PUBLIC SERVICE.

At the beginning of his career the young engineer will probably findvarious opportunities for employment in the Public Service—in fact ,a considerable proportion of his chances of getting a "job" lie in this direction. The position of the beginner seeking to get a place, trying to fit himself into some sort of niche, is different from that of the older man who has accumulated a fund of experience which is his stock in trade, and who has perforce become somewhat of a specialist. Though the engineering student has specialized in his course of study, the opportunity open to him often is not exactly in the line he would prefer, and, even if it is, there are sure to be many things in his relation to his employer and the public he cannot learn in the curriculum of an educational institution.

The Civil Engineer will find more places of public employment open to him than the student or practitioner of any other branch of engineering. For the Electrical Engineer there is less chance, and for the Mechanical Engineer perhaps still less. The Mining Engineer, or the Metallurgist, or the synthetic Chemist, is, of course, practically out of the question. But the analytical Chemist who may specialize in the direction of the practical use of the materials of construction, such as asphalt, paints, oils, cement, and other building products, will find numerous chances in the public employ. The National Government, many of the States, and practically every city, have paving and testing laboratories. Boards of health, and various other public boards find it necessary to equip laboratories for all kinds of chemical and physical research.

So the list may be multiplied. The more highly organized Society becomes, the greater the public demand for the trained technical man. The young engineer probably will find his first employment at the drafting board, in a surveying party, or as an assistant in the office or laboratory. If he is successful his responsibilities and the importance of his duties will increase. He will be, in the natural course of events, entrusted with the direction, inspection, and control of work. Up to this point, and as long as he is in a wholly subordinate position, his duties and his relations to his employers (the Public in this case) are

not essentially different from those of his classmate, who may be employed by a private corporation. The manner of obtaining and retaining his position may, however, be different. Civil Service Laws are very commonly in force in our city, state, and national governments. The intention of such laws is to remove the elements of favoritism and personal influence, and to a large extent this is accomplished. Civil Service laws provide that appointments to positions must be made from lists of applicants rated according to their ability to stand certain prescribed examinations, and after appointment one's standing is rated according to efficiency marks made by superior officers. These laws vary much in detail and manner of administration, but in general the effect is the same. It is not the intention of this article to analyze and make comparisons, or to point out advantages or defects, but only to touch hastily upon the effect such regulations have upon the employee (the engineer) and the value of his services to the public.

So far as Civil Service examinations develop the qualifications of applicants to perform certain services and insure the appointment of the best qualified, the plan is self-operative, and the personal equation is removed. Provision, however, is generally made for some period of probation within which the superior officer may reject the appointee and call for the next on the list. In this respect the Civil Service employee is on a par with any other and must make good just as though he never had stood an examination. After the period of probation is past and his appointment becomes permanent, his relative standing and chances of promotion depend upon his rating for efficiency, which is determined upon by some one in authority, whose duty it is to make such rating. The employee has the right to know what his efficiency rating is, and if he thinks he is unfairly treated he has the right to appeal. In cases where efficiency marks are low, or when the employee is guilty of some breach of conduct or rules, his superior may suspend him and file charges before the Civil Service Board. The employee then has the right to demand trial and have the matter investigated.

All these provisions are primarily intended to prevent favoritism and political preferment, and to give the Civil Service employee a measure of security in his position. Civil Service regu-

lations are, however, devised for the additional purpose of *promoting efficiency.* When they are properly and wisely administered and properly understood by the employee, this is the result. It may often happen—and has happened—that when such regulations are first put into effect, or when the employee first becomes subject to them, the idea obtains that the sole object is to protect the employee. This idea is bound to lower efficiency, destroy initiative, and make of the man a mere machine, perfunctorily performing such duties as he thinks are required of him merely to hold his "job." This is a most unfortunate and disheartening state of mind. The training of an engineer, which is intended to develop the ability to measure the relative value of things, should equip him with the sense to steer clear of this pitfall. If the earnest ambition is implanted in him to make something of himself in his chosen profession, and if he possesses the spirit to do his best under all circumtances, he will avoid it. In any specialized occupation, like the various branches of engineering, where there is an open way and an incentive continually to try for something better, the same spirit of sport than animates the successful athlete should possess the worker. Every engineer should be proud of his profession, and try to make his profession proud of him.

Of the engineer in the public service who is not under Civil Service, not so much can be said regarding the manner of obtaining his position. His employment comes by acquaintance, by opportunity, or as a political reward; if as the latter, his must be a strong nature to resist the contamination of inefficiency, and the sooner he loses his position the better.

It is not, however, by any means true, that all the best service is rendered under Civil Service regulations. In many of the minor divisions of the Public Service, in towns, villages, counties, etc., nothing of the sort is in force. In the smaller communities the sense of personal responsibility may be more acute, and the personal service of the worker is known to a much larger proportion of the employing public. Also the higher one rises in his profession, and the greater the value of the services rendered, the more do the provisions of the Civil Service laws become inoperative and useless.

Aside from all matters pertaining to conditions of employ-

ment, whether under Civil Service or not—whether of high or low degree— there are dangers and temptations which the engineer in public service must look squarely in the face. Before the mental eyes of every earnest worker there must always be the question, "Does my work pay?" For the employee of the private corporation, or for the worker for individual profit, the answer is sure to come some day. It is as inexorable as the law of supply and demand. Every enterprise that is conducted for profit (and what business is not?) must stand or fall according to whether profitable or not, and this is the standard by which every worker in such an enterprise must finally be judged. Either the ineffiicient employee must get out or the enterprise must fail.

It is not so with a public corporation like a city or state government; that must go on and on even though the majority of the employees are only forking up to a fifty per cent efficiency. It does not follow, however, that there is no reckoning for such. Although the enterprise does not fail or go out of business, and even though the wave of reform does not rise to sweep such an unprofitable organiaztion out of sxistence, there is a reaction on the individual that lowers his actual capacity for better effort, that drops him in a rut out of which his ability to climb becomes less and less. Sooner or later his inefficiency is estab--lished and he is not able to compete with the man who ever keeps before himself the question, "Does my work pay?" Here again the training of the engineer to judge the relative value an unprofitable organization out of existence, there is a reaction others to avoid so serious an error.

While the general public when aroused is ready to condemn and punish the inefficient or dishonest public employee, there is a class of the public ready to throw temptation in the way of the public employee, and if he falls, none is more ready to condemn than this same class. The temptation may come in the form of a favor to a friend, a discharge of some former obligation, or assistance to a righteous political cause. The specious argument or suggestion is advanced that nobody is the sufferer or the loser for such favors; the public pays the cost and the most deserving portion will be the gainer. The engineering employee is specially the object of such insinuating suggestions,

because his duties involve various tests that determine the acceptance or rejection of material, inspection of construction work, measurement and calculation of quantities upon which payments are made, etc. To succumb to such temptations may not be conclusive evidence of absolute dishonesty. To the Engineer in charge the danger is a slackening up of that vigilance that is the price of success. It may be that he delegates to an inexperienced or incompetent assistant important duties which should be discharged by him alone. Lacking the necessity or possibly the means of showing that his works pay, unbusinesslike methods remain uncorrected, and the efficiency of both the organization and the individual are undetermined.

Whether as an individual responsible for himself alone, or as one in authority responsible for others, the engineer in the Public Service must be somewhat of a law unto himself—must inexorably measure the value of his own services—otherwise he will ultimately recognize that he is a failure, or only half a success—which is even worse.

Much more might be said along these lines, but perhaps enough has been said to cause some to think, and he who does not think is lost.

By Linn White,
Chief Engineer, South Park Commissioners.

Electrical Measurements and Meter Testing is the title of a very useful book recently written by Professor Moreton, Associate Professor of Electrical Engineering. Professor Moreton has given a large amount of space to the fundamental theory of electric circuits and the construction of commercial instruments. The measurements covered include resistance, inductance, capacity, current, potential, power, and energy. The calibration of galvanometers, ammeters, voltmeters, wattmeters, watthour meters, demand meters, etc., is described.

The Sanitary District Board, City of Chicago, announces the contemplated expenditure of $9,072,597 during 1916.

A summary of the appropriation, which is printed in the board proceedings, is as follows:

Illinois River Bureau	$ 39,750
Chicago River Improvement	730,000
Calumet-Sag Canal	2,000,000
North Shore Canal	90,000
New Bridges	483,050
New Sewers	2,106,500
Pumping Stations	210,300
Other Engineering	360,000
Electrical Department	774,699
Police Department	41,000

The work on the Calumet-Sag canal is practically all being done by contract, and it is upon the progress of the contractors that the expenditure from the $2,000,000 set aside for this purpose depends.

The bridge appropriation includes $105,000 for the Jackson Boulevard bridge, $90,000 for the Twelfth Street bridge, $247,500 for several bridges across the Calumet-Sag canal.

* * *

Bills have been introduced in both Houses of Congress to increase the scope of the training and instruction in military science in colleges now having a detail of an army officer for this instruction so as to make the instruction more effective in training men for possible use as officers in a regular or volunteer army in case of need. The proposed law does not interfere with any other bills now before Congress or in contemplation, but proposes simply to enlarge and make more complete and efficient the facilities already offered in this line.

The graduate should understand that in spite of splendid equipment, able instructors, and vigorous discipline, the technical school does not turn him out a finished engineer, but leaves him to acquire the major part of the necessary technical knowledge after he has gone out into the world. It has given him methods of study, trained him to grasp readily the arguments of able writers, taught him the mathematics he needs, some foreign languages and something of his own, and the elements of some natural sciences, and it has made a beginning upon his technical education; but if he stops there, failure is certainly his portion. The school has accomplished its purpose, trained him mentally, but he must yet broaden and deepen his knowledge of theory, as well as learn the practical phases of his professional work.

—*Harrington.*

* * *

It is a great mistake for a young engineer to choose a specialty before he has had several years of general experience. What a source of dissatisfaction it must be for a middle aged man to feel that he has chosen the wrong line of work, and that it is too late to make a change.

—*Waddell.*

* * *

A man with all this inherent strength has no business to lessen it and curtail his usefulness and influence by not being a man of good morals, and by not using this strength to build up and help other men. There is no reason why the engineer should be blind on the moral side and every reason why he should be the opposite. I have little patience with the cob pipe, cigarette smoking, beer drinking engineer, and I believe no one else has, and I also believe that the brightest men cannot succeed in the engineering profession who is not also a good man and who is not letting his influence for right be felt by his associates, friends, and neighbors.

—*Riggs.*

NOTES FROM THE ENGINEERING SOCIETIES

THE CIVIL ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY.

At the annual election of the Armour Civil Engineering Society held in the Y. M. C. A. rooms on Tuesday, February 29, 1916, the following officers were elected:—

President .... Armin L. Schreiber
Vice-President .... Leonard E. Starkel
Recording Secretary .... Harry Stride
Treasurer .... Carrol L. Shaw
Board of Direction
Faculty Member ..... Prof. M. B. Wells
Student Member .. Stanley W. Newman

Following the election a light lunch was served and the generous supply of Havanas and Melachrinos added to the sociability.

JOINT MEETING.

At a joint meeting of the A. C. E. S. and the A. I. E. E. held in Science Hall, Wednesday, March 29, 1916, Professor Stanley Dean delivered a very interesting lecture on "Water Power Engineering." Many slides were shown which had been furnished for the occasion by the Pelton Water Wheel Co. The method of conducting preliminary surveys in order to determine the best location for dams and power houses was first explained. Various types of dams ranging from the primitive beaver dam to the modern reinforced concrete type, were shown, and their advantages and disadvantages discussed by the speaker. The construction of conduits and the difficulties sometimes encountered in mountainous regions during this phase of the work were illustrated.

The construction of the power house, particularly with reference to the installation of the water wheels and turbines was shown. In conclusion Professor Dean showed the various uses to which electric power generated in this fashion was applied.

—*Henry W. Hemple.*

FIRE PROTECTION ENGINEERING SOCIETY OF THE ARMOUR INSTITUTE OF TECHNOLOGY.

On Tuesday evening, March 14, 1916, the Fire Protection Engineering Society was greatly honored with an excellent lecture on "Dry Pipe Valves," by Mr. C. Hendricks, Hydraulic Engineer, Underwriters' Laboratories. The lecture was very instructive and of especial interest to students of the Fire Protection, because it reviewed in a very clear manner the standard sprinkler equipment, the various types of dry pipe valves, and outlined the report put out by the Laboratories on these valves.

Mr. Hendricks illustrated a standard equipment in a four story mill constructed building. This he divided into five parts:—(1) underground mains; (2) riser; (3) cross mains; (4) branch lines; (5) pressure or gravity tanks. The system may be run either wet or dry, according to conditions. If it is run dry, a dry valve must be used. The dry valves described by Mr. Hendricks were the Grinnell No. 12 and the Grinnell straightway as illustrations of the differential type, and the International or "Evans" valve to illustrate the mechanical type.

The work of the Underwriters' Laboratories is, in the words of Mr. Hendricks, to manufacture reports. A report, describing the device and giving the information outlined below, is sent to the members of the Underwriters' Council consisting of about twenty insurance men from all over the country. Each one gets a report and votes by mail on the recommendation of the Laboratories. If the majority vote in favor of the device, it becomes standard.

The report is put out in standard form. The first chapter is an introductory one. It describes the device giving its use, parts, etc., illustrated by external views and diagrams showing the internal parts. This chapter also gives the claims made for the device and the general plan of investigation outlining the process of reasoning leading to the conclusion. The following seven phases and subsequent features of the valve are discussed:—(1) Design and construction of the valve giving the form and arrangement of parts, suitability of materials and workmanship; (2) Practibility (a) of installation, (b) of setting, (c) of maintainance; (3) Durability considering (a) wear and tear, (b) rough usage, (c) corrosion; (4) strength (a) of parts, (b) of

assembled device; (5) Reliability considering the positiveness and promptness of the operation; (6) Accident hazard caused by hazardous surfaces or structural weakness; (7) Uniformity (a) of parts, (b) of assembly.

Another chapter is devoted to the examination and test record. The following examinations and test are made on the valve:—(1) Study of design; (2) Properties of materials; (3) Tests of materials; (4) Examination of device comparing it with the standard, item by item; (5) Installation test; (6) Operation test; (7) Gaging test to ascertain whether or not it would be easy to fix the valve so as to make it inoperative; (8) Manipulation test; (11) Corrosion test; (12) Strength test; (13) The hydrostatic pressure test; (14) Specifications in regard to the bolting of covers, etc.

The report is completed with the following topics:—(1) Record of the valve in service; (2) Manufacturers' chapter, giving the standing of the concern; (3) Form of supervision of the product by the Laboratories; (4) Improvements; (5) Conclusion; (6) Recommendation.

This completes the outline of Mr. Hendricks' lecture but does not do him justice, for it fails to convey the clear and concise way in which each part was treated. The Society regrets the fact that Mr. Hendricks did not have sufficient time to complete his lecture and assures him that he will be more than welcome to speak before the Society in the near future.

A Corman.

* * *

Some persons devote much time in passing opinions stating what they think. It does not make much difference what you think about things. It is what you do about them. There is even danger of thinking too much unless thought is intuitively coupled with action. Your thoughts may sometimes wander harmlessly, but your acts need be right all the time.

THE ALUMNUS

Being That Part of **The Armour Engineer** Devoted to Personal Mention of the Graduates of the Armour Institute of Technology and to the Affairs of the Armour Alumni Association.

Edited by the Publication Committee of the Armour Alumni Association.

T. A. Banning, Jr. F. T. Bangs W. A. Kellner

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SPRING MEETING AND REUNION.

Wishing to co-operate with student activities, the Armour Alumni Association has named Thursday, May 4, as the date of the annual spring meeting. This date falls during Junior Week and the particular day chosen is Circus Day.

There are many alumni who never have had the opportunity of attending a Circus Day at Armour Institute, chiefly because the day devoted to antics and the antithesis of all that is serious was not instituted at the Alma Mater until three years ago. So the opportunity is presented. We wouldn't for the world mention that there will be a band and that they will burn calculus or something or other at the stake. That would be too much publicity for the boys.

The meeting this year will be along the same happy lines that have prevailed at similar meetings at the Institute during years gone by, but with a few differences that should make for a still happier time. The fact that it will be held on Thursday instead of Saturday will be one of them. The real doings will begin at

3 o'clock p. m., and though Thursday is a workday, it should not interfere with good alumni coming; it will only interfere with their business, while the Saturday meeting would interfere with some of their week-end pleasures. And there's a difference, you may confess.

Sometime between 6:30 and 7 o'clock there will be a general adjournment to the gymnasium for the business of feasting. After that the program is open. In fact, there will be no program, no notables, no special features, no anything. That is, we mean, that will be announced. The price per plate will be $1.25. And those alumni who find it impossible to come during the afternoon, should stop off at Thirty-third and come to the banquet. The big doings will be in the evening, though they should not miss the afternoon fun. It is up to them to get their money's worth, for it will be there if they want it.

To the Seniors the news will be broken gently. They, being so near to graduation, and therefore near-alumni, will be allowed to step over the border for a few hours and will be given the same privileges as alumni; in fact, their invitation to the banquet is even more cordial. The price for banquet tickets will be the same for them, though they may take advantage of receiving a free ticket if they pay the Alumni Association initiation fee and a year's dues, amounting to $2.

ALUMNI NOTES.

S. M. Peterson is employed by Pond & Pond, architects, 64 East Van Buren St., Chicago.

C. W. Garrison, '13, has accepted a position with the *Engineering News,* New York City.

G. W. Sproesser, '15, is associated with the Sioux Falls Construction Co., Sioux Falls, S. D.

O. A. De Celle, '14, is chemist with the International Filter Co., First National Bank Bldg., Chicago.

T. J. Kiene, '15, is with the Concrete Engineering Co., 608 Omaha National Bank Bldg., Omaha, Neb.

H. C. Frisbie, '09, has been appointed general manager of the Cornell Wood Products Company, Cornell, Wis.

H. M. Sharp, '05, chief engineer of the State Highway Department of Ohio, was a recent visitor at the Institute.

W. S. Pfeifer, '15, is with the Economy Fuse & Manufacturing Co., Kinzie and Orleans Sts., Chicago.

F. J. Mack, '12, is with the Condron Company, contractors, 1215 Monadnock Blk., Chicago. His address is 3552 Lexington St.

C. A. Knuepfer, '15, is secretary and production manager of the Automatic Screw Machine Products Co., 416 Grand Ave., Chicago.

Arne Bodholdt, '15, is in the drafting department in the offices of D. L. Davis, consulting engineer, 431 South Dearborn St., Chicago.

W. V. Lindblom, of the class of '15, is employed by C. F. Drake, management engineer, with offices at 72 West Adams St., Chicago.

W. F. Conlin, '09, is now employed by the Schoenberger Steel Works of the American Steel & Wire Co. His address is Penn Ave. and 15th St., Pittsburgh, Pa.

W. H. Rietz, '15, who has been with the National X-Ray Reflector Co., developing reflectors for combination diffusion and concentration of light, has left that company and is with the Illuminating Electric Co., Chicago.

W. E. Miller, '01, recently was appointed assistant manager of the German American Insurance Company, 76 W. Monroe St., Chicago. Mr. Miller graduated from inspection work into the insurance field. He spent eight years with the Connecticut Fire Insurance Company, later was state agent in New York for the Continental Fire Insurance Company, and in 1909 took the Illinois field for the German-American Company, where his excellent work won for him his recent promotion to an official of that company.

H. W. Clausen, '04, engineer of waterworks construction, City of Chicago, gave an illustrated lecture before the Western Society of Engineers April 17 on "The Construction of the Wilson Avenue Tunnel." The paper described the unusual construction details of the work on the tunnel, which is eight miles long, and is being mined in solid rock 165 feet below street level. The finished bore of the tunnel is 12 feet, and many novel methods were used in mining and concrete lining. Methods by

which day labor employed by the City of Chicago is being handled at lower cost than by contract were explained. The tunnel will be used to supply water to a new pumping station located near Wilson and Milwaukee Avenues.

F. C. Clark, '05, who superintended a large part of the electrical construction work of the Panama Canal, assisted in the preparation of a paper entitled, "The First Year's Operation of the Panama Canal Locks," and read before a meeting of the Western Society of Engineers in Chicago, April 3, by S. H. Granten, in the absence of the authors, Mr. Clark and R. W. Whitehead, who are now respectively superintendent and assistant superintendent of lock operation. The paper was very comprehensive and brought out some interesting facts. In the first year of actual operation 1,370 vessels were locked through the canal without any accident whatever. The entire operation of the locks has been very satisfactory. The control apparatus has given excellent results and it was only by use of such a control system that so large a system of locks could be operated properly. Both up and down lockages are made at about twice the speed that was anticipated. Both lock operators and canal pilots were given very careful training. The night illumination of the locks has proven entirely satisfactory, so that vessels can pass through the locks as freely as night as by day. Electric locomotives used in towing and guiding vessels through the locks were designed for a speed of two miles per hour. It was feared this speed was too high when it came to handling very large vessels, so a scheme by which the locomotive speed could be reduced to one mile an hour was developed through concatenation of the motors. It has been found, however, that practically all vessels can be maintained at the speed of two miles an hour without danger or trouble. Bids are now being sought on a number of additional towing locomotives, in which certain improvements are to be incorporated. The operation of the locks has produced some very interesting phenomena. Peculiar problems arose due to the difference in salinity on opposite sides of the lowest lock gates which produced difference of level and set up peculiar currents in the water. It has been found best to follow a definite cycle of operation in opening and closing the mitering gates and the various sets of valves.

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(Signed) ARTHUR KATZINGER,
Business Manager.

Sworn to and subscribed before me this 6th day of March, 1916.

[Notary Seal] JULIA BEVERIDGE,
Notary Public.

My commission expires January 8th, 1918.

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*Prepared by Ellen C. Broomell, Ph. B., Assistant Librarian, Armour Institute of Technology.

SUPPLEMENT.

Copies of these bound volumes are on file in the Library of the Armour Institute of Technology.